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# Promising Development

An extremely interesting investigation has been carried out at the College of Aeronautics, Cranfield, into the "Application of Sub-sonic Vibrations during Solidification of Castings with Particular Reference to a Material for Gas-turbine Blades—'H. R. Crown Max'." As most foundries possess moulding machines with a vibrator attachment for pattern-stripping, it is relatively easy to make rough tests on these lines, and thereby evaluate whether any benefits can accrue from such treatment. Actually, such tests have been made in one foundry with excellent results, but although they showed promise they were not continued. The good results obtained from the research mentioned earlier are basically due to the removal of the typical columnar crystal structure on solidification and the substitution of a uniform equi-axed grain. They are also reflected in better mechanical properties. It should be borne in mind that the work at Cranfield was done on one type of material and one pattern of fixed dimensions. The authors of the Report, well knowing the innumerable variables to be associated with casting production, wisely state in their introduction: "every new casting tends to be a triumph of hope over experience and the final result of many experiments."

Vibrations have two properties—amplitude and frequency—and it is the latter which has been shown to be the more important. The authors have only used 23 and 48 cycles per second and amplitudes of 0.005 and 0.12 in. The casting temperature is obviously still important. For the material with which the authors experimented (H. R. Crown Max.) the following improvements were registered; the tensile strength increased from 37.2 to 43.2 tons per sq. in.; the elastic limit went up from 16 to 21.5 tons per sq. in.; elongation was better at 41 per cent. as against 33 in the untreated alloy; the reduction of area obviously behaved similarly, with a figure of 36 as against 27 per cent.; the balanced-impact strength rose from 9.6 to 13 ft.-lb., whilst —and this is the important figure—the grain-size was reduced from three to 15 grains per sq. c.m.

Considering that the process is the essence of simplicity, inexpensive, and one that could be tested in any foundry, its appeal is apparent. The objective is the noteworthy one of bestowing upon castings properties more nearly approaching those of wrought material. The initial results are promising, but there remains much more work to be done to ascertain the optimum vibration conditions, pouring temperatures and, above all, suitable mould materials, which will resist the vibratory impulses without damage. It is a subject which could with advantage be investigated by the foundry research organizations. Is it too fantastic to imagine that in the future, cooling conveyors will be provided with vibrators?

**HARRY S. BROOM, M.I.Mech.E.**

*Joint Founder and Chairman; Broom & Wade, Limited.*

# *Leaders of the Industry*

## HARRY S. BROOM, M.I.Mech.E.

"ENGINEERING! You'll never be more than an oily mechanic! You'll never earn more than thirty shillings a week at that game!" Despite this rather gloomy prophecy from his brother, Mr. Harry S. Broom—by his own unrelenting efforts and dogged determination—has built up a thriving engineering and foundry business, Broom & Wade, Limited, compressed-air specialists, with world-wide interests and subsidiary companies active in Australia, South Africa and Canada.

But this success story springs from a very modest beginning. Born at Moulton, Norfolk, in 1875, Mr. Broom, at the age of 15, was apprenticed to an engineering shop in Norwich at a wage of 5s. per week. There, with a "sweat rag" round his neck, he learned the rudiments of engineering practice in a hard school. Studying assiduously in his spare time, he gained honours both for higher mathematics and his design for a plunger pump.

Later, he obtained a post at the engineering works of Davey Paxman & Company, where he met his future partner, Jethro Wade. When still only 20, he built a refrigerating plant which led him to the study of compressed air. While Wade was building their first workshop—a shed in a High Wycombe cornfield—Harry S. Broom and two apprentices took on any odd jobs in the vicinity to pay for it. With assets consisting of a 6-in. lathe (which Broom had built himself), some technical books and about £20 in cash, the partners' first output was wood-working machines for the High Wycombe furniture industry.

Hard work, persistence, and belief in the future of compressed air for industry bore fruit with the first big order for 71 air-compressors for railway brakes on London's Underground system. Mr. Broom subsequently obtained the agency for the Hyatt Roller Bearing Company, which later led to his joining the boards of Vauxhall Motors, Delco Remy & Hyatt, and Frigidaire. Nowadays, the two-man business started in a cornfield, occupies 14 acres, employs a total of 1,400, has subsidiary companies and agents all over the world, and an authorized capital of £1 million.

Mr. Broom celebrated his eightieth birthday last July. His son, Mr. H. "Dick" Broom, M.B.E., B.Sc., M.I.Mech.E., is president of this year's Engineering, Marine, Welding and Foundry exhibition which opens at Olympia to-day. Mr. Broom, senior, is at his desk every day and is still very much a driving force. In the words of a co-director, Sir Percy Lister: "I never knew a man work so hard, play so hard, and get so much out of life." Mr. Broom is a member of the Institute of Mechanical Engineers and a past-president of the British Compressed Air Society.

Though the ceaseless expansion of the business is a full-time job, he nevertheless occasionally finds time to indulge in hunting, shooting, fishing and yachting. "When I look back on the ups and downs of my career," Mr. Broom says, "I think my greatest satisfaction was the introduction of our employees' profit-sharing scheme in 1928. I like to think of the men and women who work for me as partners, rather than employees. It is their loyalty and their team spirit that has carried the firm to success."

# Correspondence

## INTERESTING DEVELOPMENTS

*To the Editor of the* FOUNDRY TRADE JOURNAL

SIR,—I would like to comment on an editorial which you wrote in the JOURNAL of July 21, in which you mentioned some developments in foundry technology which are of active interest in North America. With respect to the production of steel wheels for railway wagons by casting into graphite moulds, many excellent wheels have been made by the process and a very fine casting is possible.

We have some interest in this wheel question, since we make the majority of chilled cast-iron wheels produced in Canada, and are considering the manufacture of a cast-steel wheel. This will be by a process developed by the Southern Wheel Division of American Brake Shoe Company in the United States, and involves the use of moulding equipment very similar to that used for chilled cast-iron wheels, wherein a green-sand mould is used with a chill ring around the tread to provide directional solidification. The composition of the steel has also been changed from normal steel-wheel practice and a 1.50 per cent. carbon steel is used to provide better foundry conditions, as well as better wearing qualities. A spherodizing heat-treatment is also applied. This wheel has proven practical in both plant operation and service tests in the United States and has given good results in Canada where weather conditions are hard on wheels.

With respect to the high-density coke known as "Densite," this has aroused considerable interest and we have made trials of it in some of our grey-iron foundry operations. There is no question that higher carbon contents can be obtained in the iron, but the price of the coke is so high as to rule out any question of commercial application, for us at least. The price of this coke laid down in one of our plants is $70 per net ton, whereas first quality by-product foundry coke is laid down for $29 net ton. No imaginable increase in efficiency can absorb such a differential, and its commercial usefulness would appear to depend on this price factor.

With respect to injecting various materials into molten iron by inert gases, this is a very active field in Canada and the United States and practically everything has been blown into a ladle of iron that could be imagined. The principal interest is that very high surface-contact areas can be obtained between powdered materials and the iron when injected in this manner, and reaction rates are high; for example, blowing powdered quicklime into the iron can result in efficient desulphurization, and desulphurization by calcium carbide is feasible on a commercial basis only when injected as a fine powder.

With respect to injecting carbon or graphite in this manner, a most promising and interesting field is developing since really appreciable amounts of carbon can be added to the iron quickly by this method and we have done considerable plant development work on it. For example, it is practical to increase the carbon content of a ladle of iron by 0.50 per cent. in a matter of minutes, with efficiencies of recovery of the order of 80-90 per cent. of the carbon added, and recently we injected graphite into the iron in a forehearth of a continuously operating cupola running at 17 tons per hr. The injection was continued for a period of four hrs. during which the carbon content of the iron was continuously raised by 0.20 per cent. Incidentally, chill reduction is drastic. Our interest at the moment is in increasing carbon content on a continuous basis and the problem is largely one of a suitable tube to withstand the continued immersion, and this appears near solution. A little thought will make it evident that there are many possibilities for this procedure, both from the viewpoint of increasing carbon content in low-carbon-content cupola charges, and for control purposes. A paper on injection of carbon was given by Schneidewinde *et al.* at the recent American Foundrymen's Society convention, and the work reported there was on techniques and especially on the mechanical properties and metallurgical characteristics of irons so made. Our development has been a parallel one, but in the direction of working out a practical commercial way of changing the carbon content of the iron for both cost and metallurgical advantages.—Yours, etc.,

J. E. REHDER.

Canada Iron Foundries, Limited,
Montreal.
August 22, 1955.

# Congress Paper Author

Dr. Dott. Ing. Romolo Baggio, Author of the official Italian Exchange Paper—"Quality Control in a Large Foundry in the Automotive Industry"—printed on page 229 of this issue, was born in Rome in 1891 and studied at the Academy and the School for Artillery and Engineering Practice prior to taking up a military career in the Artillery. After serving in the first world war, he resumed his studies at the Turin Polytechnic, and in 1922 gained a degree in mechanical industrial engineering. He then entered the Artillery Technical Service, in which he served for a number of years in various capacities, including that of head of the Pyrotechnical Testing Commission of Capua (cartridge manufacture) and subsequently at Piacenza arsenal (ordnance and projectile manufacture). After a distinguished military career he left the service with the rank of Major-General of Artillery. Dr. Baggio then studied, and later carried out practical tests with ordnance material, his work being referred to in General Montu's "History of the Italian Artillery," volume XII. In February, 1944, he took up an appointment with the Fiat foundries, in which establishment he is at present discharging the duties of head of the testing department.

# Foundry Science Course at Borough Polytechnic

A special course of Foundry Science for the mature type of student has been arranged at the Borough Polytechnic (Department of Mechanical Engineering), Borough Road, London, S.E.1, for the 1955/56 session. This course is designed to give a general knowledge of scientific principles applied to foundry processes and will be suitable for technical sales representatives, furnace operators and others connected with the industry, who already have a basic knowledge of foundry practice. The duration of the course is for one complete session of 26 weeks. Classwork and homework exercises will be set throughout the course, but there will be no end-of-term examinations. The fee for the course, one evening per week, is 25s. and students must be 21 years of age or over before admission.

Enrolment for the course will take place at the Polytechnic on September 21 and 22, and it will commence on Thursday evening, September 29, at 6.30 p.m.

# Quality Control in a Large Foundry in the Automotive Industry

*By R. Baggio*

*The Author discusses the aims of modern quality-control and shows how these no longer concentrate simply on separating defective from sound castings, but provide a means of preventing the production of faulty castings by instituting regular checks and controls at all stages of manufacture. Methods of quality-control, using the most up-to-date techniques suitable for foundry work are reviewed. The controls adopted in the FIAT foundries in Turin are described in detail—applied to the production of iron, malleable iron and light-alloy castings used in automobile construction. The possibilities of using statistical control for quality in foundry practice is also discussed.*

## Introduction

Modern concepts of quality control in foundries differ substantially from the older methods which relied on inspection to pick out all faulty castings. Modern techniques consist in conducting tests *during* manufacture which makes it possible to take preventive action. These tests, moreover can be planned to have the maximum effect with a minimum of resources, equipment and personnel, by concentrating on "strategic points" designed to eliminate all irrelevant variables.

To this effect, quality control in foundry work is directed to raw materials, moulding equipment, patterns, moulds and metal, and to all phases in the production line. By this means it is possible to reduce to a minimum the inspection of individual finished castings.

The tests which are to be discussed are grouped under the following headings: I, optical and dimensional tests; II, technological tests; III, heat-treatment tests; IV, analytical tests; V, X-ray tests; VI, macrographic and micrographic tests; and VII, physical and mechanical tests.

## I—OPTICAL AND DIMENSIONAL TESTS

### (a) Equipment

All new equipment, including patterns, metal moulds for die- and pressure-die-casting and core-boxes, are submitted to careful dimensional inspection and are checked against drawings. If all the equipment is found to be in satisfactory condition, test castings are made and carefully inspected. Should there be any defects, these are traced back to faults in the pattern or core, and in the case of die-and pressure-die-castings, to defects in the metal mould.

All equipment is, of course, subject to wear during production. The abrasive action of the sand on patterns and coreblowers and the continuous action of molten metal on the dies unavoidably produces changes in dimensions. The systematic adoption of dimensional controls, during the initial stages of manufacture contributes to reduce the production of defective castings.

Every day, inspection personnel examine all mould and core production set-ups and immediately report any defects. If need be, they can hold up production until satisfied that quality is up to standard. Similar action is taken on all moulding machinery. On gravity- and pressure-die-casting production lines, inspection personnel is constantly on the look out for defects attributable to moulds or dies so that necessary measures can be taken in time to put matters right.

### (b) Cores

Cores are submitted to a number of controls both when "green" and after drying. All are examined "green" for defects such as spalling due to bad ramming. After drying, cores are cooled in air and examined once more to see that they are uniformly baked and that no subsequent spalling or deformation has taken place.

Small cores are submitted only to a visual inspection which is carried out on some 10 to 20 per cent. of those produced. Larger cores are submitted to a detailed examination with calipers and gauges; any defects are put right and the cores are then finished, after which they are assembled, coated, dried, checked once more for correctness of dimensions and carried by conveyor to the moulding lines.

In cases where a number of cores has to be put together (*e.g.*, with cylinder-block castings for cars and lorries), the units are assembled before they are sent to the moulding lines. With motor-car and lorry crankcases, the cores are assembled on the moulding lines and held firmly in place by means of assembly jigs. (See Figs. 1 and 2.) The position of the core-assembly in the mould is then carefully checked to see that all dimensions are within the limits specified.

### (c) Castings

*Grey-iron Castings.*

Grey-iron castings are examined visually and submitted to a dimensional test after knocking out and fettling. With small castings, testing is limited to 10 per cent. of the total production. In all cases where recurring defects are found, the percentage

* Official Exchange Paper from the Italian Foundrymen's Association, presented at the fifty-second annual meeting of the Institute of British Foundrymen and International Foundry Congress in London, last June. The Author is attached to the FIAT foundry at Turin.

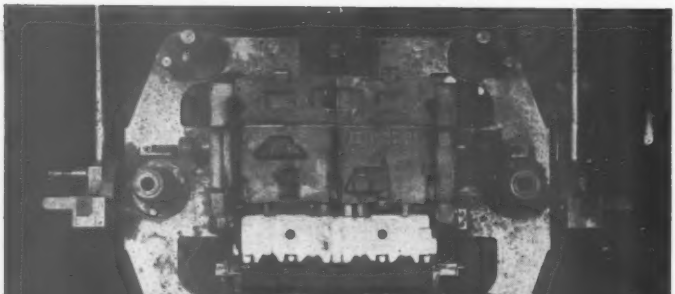


FIG. 1.—*Assembly jig for cores for motor-car cylinder-blocks (vertical elevation).*

of castings examined is increased. All large and important castings, such as crankcases and cylinder-heads, undergo thorough dimensional examination.

Visual inspection ensures that castings are free from surface defects and blowholes. This is particularly important where surfaces are to be in contact with lubricants or cooling water. Dimensional testing of small castings is done by means of calipers; but larger castings (crankcases and cylinder-heads) are carefully checked for size in specially constructed jigs.

Gauging consists in marking out a number of location-points on the castings which serve as measuring points and are used subsequently for marking out and machining. The location-points are obtained by milling the castings while firmly held in assembly jigs. Once this operation is completed, the castings are then placed in the measuring jigs and checked dimensionally.

*Malleable-iron Castings.*

The first visual inspection of malleable castings is done prior to heat-treatment, so as to eliminate all castings with obvious defects. A second visual inspection is carried out after heat-treatment to see that castings are not distorted. The more important castings are checked individually for size with calipers and in jigs. Only a portion of the smaller castings is individually inspected.

*Light-alloy Castings.*

After fettling, castings are submitted to visual and dimensional tests. The percentage of castings inspected depends on the type of casting, the standard of quality demanded and pouring characteristics of the alloy. The larger castings, as with the other groups, are all individually inspected and checked for size by means of calipers and measuring jigs.

All experimental and new types of castings which may present technical difficulties in their manufacture are sectioned and examined for wall-thickness and surface quality. In the course of normal production, castings are occasionally sectioned to see that their internal configuration reaches standard.

## II—TECHNOLOGICAL TESTS

Parallel to the problem of examining defective castings, is the problem of eliminating the causes of defects. Technological tests on samples make it possible to find whether production materials conform to the required specifications. These tests are designed therefore to be carried out on all sands, binders, refractories and alloys; they provide a check on the physical and mechanical properties of the metals; they ensure that the correct alloys are used and that all production techniques are suitable.

### (a) Control of Raw Materials

The control of materials entering the works is based on specifications drawn up for all metals and alloys, sands, binders (both organic and inorganic), refractories, and all machinery and equipment in general.

All consignments of sand are examined for grain size, fineness number, and impurities. Periodically, sands are also examined for their chemical composition, refractoriness and grain shape. Sand mixes are examined for flowability, density, green- and dry-strengths, baking characteristics, gas evolution and losses on ignition (see Figs. 6, 7, and 8). Gas evolution is considered particularly important and must not be greater than can be easily dealt with by the permeability of the sand.

Binders are checked with standard sand-specimens for fineness, permeability and green-strength. The "ageing characteristics" of bentonites are determined by studying the green-strength developed on re-constituting after repeated heating to 400 deg. C. for one hour. The test is conducted on small samples of sand containing 7.5 per cent. of bentonite (Fig. 9).

All ferrous and non-ferrous metals and alloys delivered to the works are chemically analysed. Refractory sands for monolithic furnace linings are checked for chemical composition, grain size and refractory properties. Refractory bricks are examined for size, specific weight, surface defects and tendency to spalling. All machinery and equipment is carefully inspected to see that it conforms to drawings and specifications and is finally tested in operation.

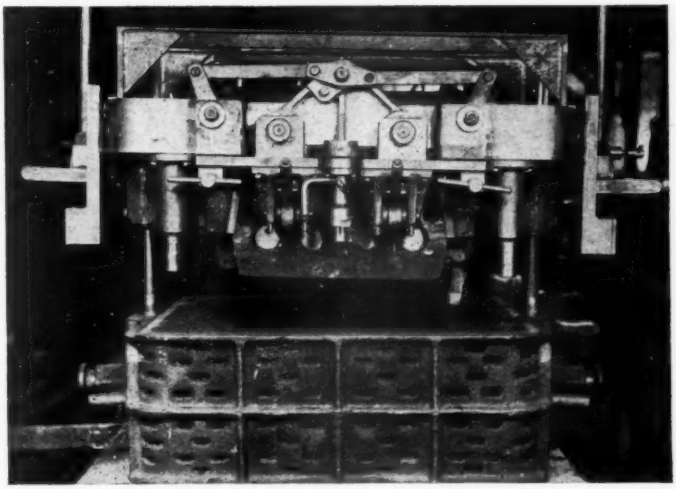


FIG. 2.—*Assembly of cores for a motor-car cylinder-block (lowering into mould).*

### (b) Moulding Sands

The Fiat foundry has four mechanized production lines, all using synthetic sands (for small, medium and large iron castings, respectively, and one line for light-alloy castings). Each line uses a synthetic sand of appropriate composition. Basically, these sands are composed of well-washed silica sands to which are added cereals, blacking, bentonite and wood-flour. Samples are taken every hour from each line and tested for green-strength, permeability, moisture and test-piece density. In addition, once a day, a sample of sand is taken from each of the three lines producing iron castings and tested for collapsibility. This test is carried out on samples dried at 120 deg. C. (Fig. 10). Expansion coefficients are determined periodically at 816 deg. C. These tests are important, as they indicate whether the average expansion while casting is within the prescribed limits (1 to 2 per cent. of sample length); (Fig. 11). Resistance to compression is also checked periodically at 538 deg. C., and so are grain size and impurities.

Briefly, the preparation of all synthetic sands is carefully controlled. All quantities of sand (both reclaimed and new) are carefully measured through feeders. Reclaimed sands are examined for composition and temperature before they are returned to the moulding machines. Losses on ignition for moulding sands must not be less than 7 per cent.; smaller losses are corrected by adding coal-dust to the sand.

### (c) Moulds

The surface-hardness of moulds is tested while the moulds move along conveyors, and must be within specified limits. Any anomalies are remedied by varying the number of jolts to which the moulds are subjected on the machines. Large moulds are checked for hardness below the surface by means of a special instrument. The test provides a guarantee against collapse under metal pressure.

### (d) Core Mixtures

Core preparation for iron, malleable and light-alloy castings is concentrated in one department.

FIG. 3.—*Gauge for motor-car cylinder-block (side view).*

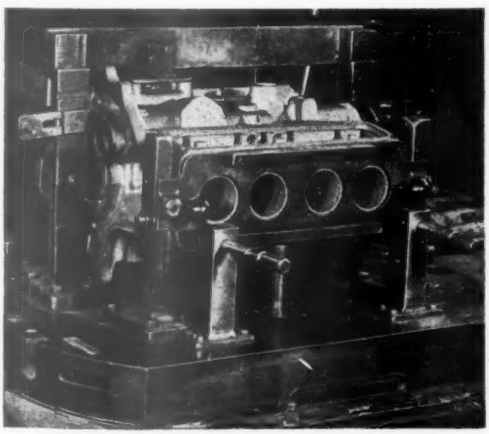
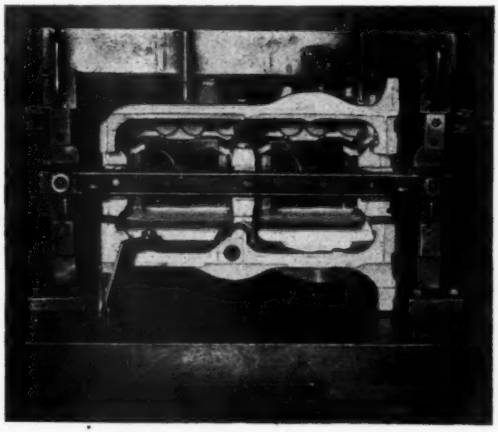


FIG. 4.—*Gauge for motor-car cylinder-block (looking down into the block).*



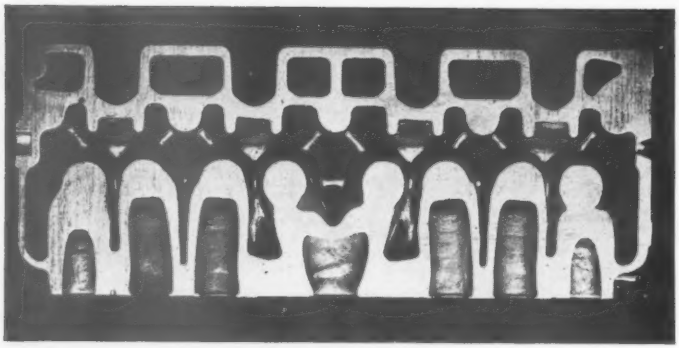


FIG. 5.—*Light-alloy cylinder-head (cross-section showing the wall thickness).*

The different core mixtures are carefully prepared to comply with requirements. Core mixtures for aluminium castings need lower dry-strength but greater collapsibility than those for iron castings.

Notices specifying clearly the constituents of the different core mixtures are posted at all places where mixtures are prepared.

A thorough examination of all core-mixture characteristics is conducted systematically for each mixture. A.F.S. standard samples are tested for green- and dry-strength (Fig. 12), permeability, loss on ignition and scratch hardness.

### (e) Metallurgical Tests

*Grey-iron Castings*

In addition to the chemical analysis of every heat, a sample of iron is taken and cast into a small wedge test-piece. (Angle at the Vertex = 13 deg.) (Fig. 13). If the analytical composition of the iron is found to be normal, but the chill characteristics of the test-piece differ from standard, the iron must be impure or improperly de-oxidized.

Slag tests are carried out for the information they yield on iron quality. It is found that a high iron-oxide content in slags produced in acid-lined electric refining furnaces, indicates that the iron is oxidized. In practice, it is found that the colour of the acid slag tends to change from very dark green to pale green as the content of iron-oxide decreases. In addition to this visual control, slags are tested to ensure that their FeO content is always below 5 per cent. after refining.

Contraction tests are carried out on different types of cast iron with an apparatus giving continuous contraction readings plotted against cooling time. For this a small iron bar cast in normal foundry sand is used, and contraction is amplified by means of electronic equipment. (Fig. 14.) The test enables comparisons to be drawn between two or more irons and provides, experimentally, data which make it possible to forecast the ultimate contraction to be experienced in the castings.

*Malleable Iron Castings*

Structure control of malleable cast iron is carried out on 45-mm. dia. circular test-pieces. These must show a completely clean, white fracture. In addition, a number of actual castings (door hinges, brake drums, etc.) are broken and examined prior to fettling and sand blasting, here, too, the fracture must be white (cementite in a pearlitic matrix). Graphite segregations are not tolerated, and all castings exhibiting this defect are immediately scrapped.

*Light-alloy Castings*

The most common faults in light alloy castings are: Porosity, scabbing, surface defects, slag inclusions, coarse grain, internal stresses and hard spots. These may be attributable to metallurgical causes, as in the cases of coarse structure and internal stresses, but they may also be due to a variety of other reasons—hard spots, for example, are generally due to extraneous elements, to slag or brick fragment inclusions.

Melting furnaces are charged with carefully selected materials to avoid the presence of contaminating alloys. Specifications lay down the proportions of original charge and make-up materials. The castings are systematically checked for chemical composition. They are then submitted to X-ray inspection and mechanically tested.

In addition to the tests described, a number of special tests is conducted when production or service conditions make it necessary to do so. An example is the "hydraulic test" carried out on cylinder-block and cylinder-head castings, in which these are submitted to a six-atmosphere pressure. Both iron and aluminium castings are tested in this manner. In the case of heavy tractor castings, the test is done before machining but with motor-car castings, the test is carried out after machining.

## III—HEAT-TREATMENT TESTS
### Grey and Malleable Irons

The need for controlling the temperature of the iron both when in the refining electric furnace and when pouring, is well known. In the furnace, the reactions which take place between metal and slag are closely linked to temperature, which cannot be varied except within very narrow limits. The same is true of pouring temperatures, if these be too low, this may result in dendritic structure with a corresponding reduction in strength.

The principal advantage of the electric furnace is that it enables temperatures to be controlled within the narrow limits required. Pouring temperatures are constantly checked by means of optical pyrometers.

In all heat-treatment operations, and particularly when annealing malleable cast iron, the various phases through which cementite and austenite solutions pass, and the subsequent transformation of

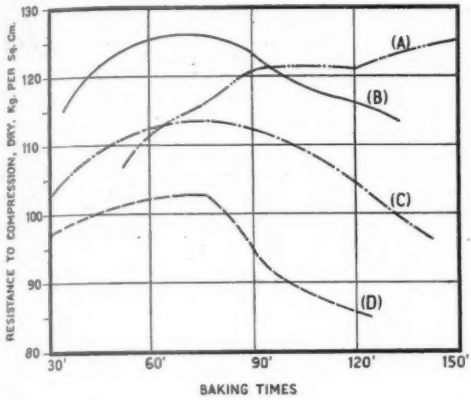


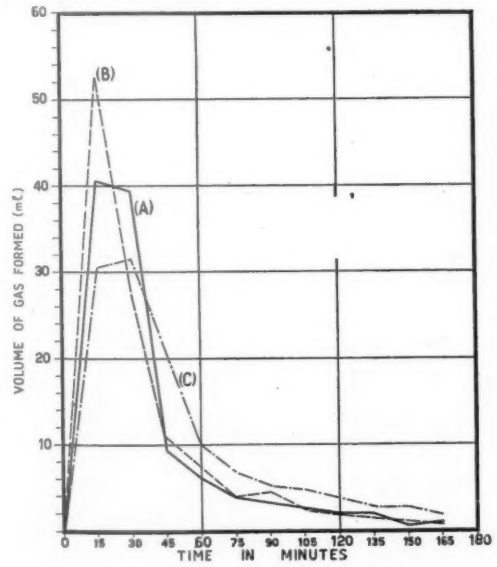

FIG. 6.—*Compressive strengths of core sands bonded with different binders, baked at 220 deg. C. for various times.*

pearlite into graphite and ferrite, are carefully controlled by means of recording pyrometers.

### Light Alloys

In the Fiat foundry, most light-alloy castings are both melted and heat-treated in electric furnaces. All melting furnaces have automatic temperature control, which makes it possible to guard against overheating. To this must be added the advantage

FIG. 7.—*Evolution of gases in core mixtures bonded with various oils, for iron castings (tested at 1,300 deg. C.; volumes converted to 0 deg. C. and 1 atm. pressure).*



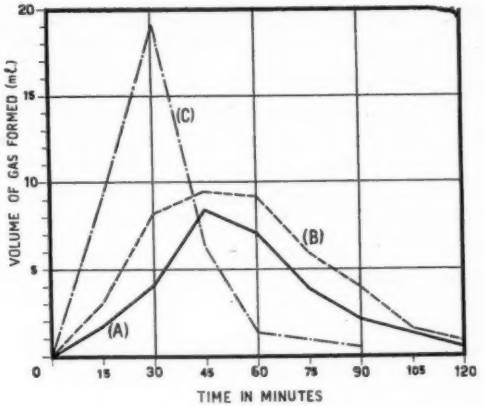
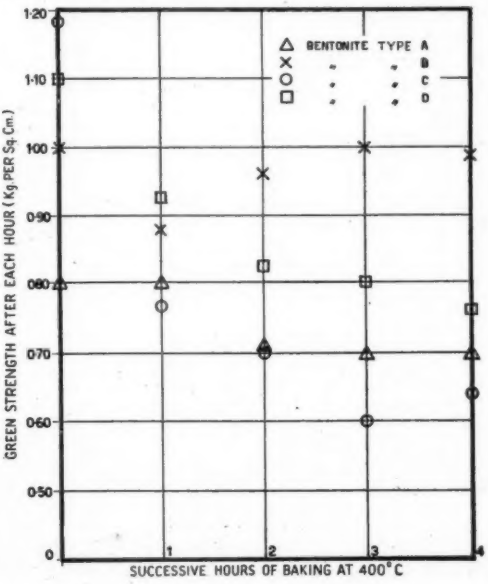




FIG. 8.—*Evolution of gases in core mixtures for light-alloy castings with various binders: (A) linseed oil, (B) fish oil, and (C) urea-formaldehyde resin (tested at 725 deg. C. volumes converted to 0 deg. C. and 1 atm. pressure).*

that noxious gases are practically non-existent in electric furnaces. The risk of picking up harmful gases and producing porous castings is therefore practically nil.

Temperature control of pressure-die-casting metal is effected by thermocouple. Mould temperature is checked by means of low-melting-point alloys. The heat treatment of aluminium-alloy castings is carefully specified for type of alloy and type of casting.

FIG. 9.—*Ageing tests for a selection of bentonites.*



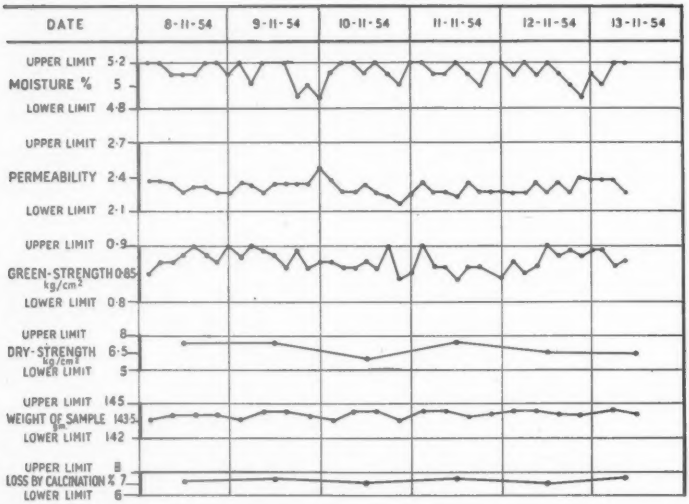



FIG. 10.—*Characteristics of moulding sands used for large castings.*

The temperatures of all furnaces for heat-treating and ageing are automatically controlled to within ± 3 deg. C. by means of potentiometer/recording pyrometers.

## IV—ANALYTICAL TESTS

In a mass-production foundry, the frequent analytical testing of alloy composition is considered to be essential. The Fiat Research and Control Laboratory is well equipped with modern apparatus for this purpose

### (a) Cast Iron

Chemical composition of grey and malleable irons is controlled, on the average, hourly during refining and when the metal is held in receivers. For this, samples of the iron are taken, cast into small circular discs and chilled rapidly to give parallel faces. (See Fig. 16). The discs are then taken to the Quantometer and sparked, using a high-purity-graphite electrode. The Quantometer is calibrated to record percentages of silicon, manganese, copper, chromium, nickel and molybdenum contained in the iron.

Total carbon is determined by a Strölheim instrument on drillings taken from the original sample. Phosphorous and sulphur contents are consistently low in irons produced in electric furnaces and need only be checked occasionally.

The results of the analyses are returned to the furnaces after about 12 mins. Fig. 17 gives Quantometer values of the principal elements (Si, Mn, and Cu) in a current type of grey iron. Approximately 80 samples are analysed daily (two 8-hour shifts) which means that some 400 elements are determined each day.

### (b) Light Alloys

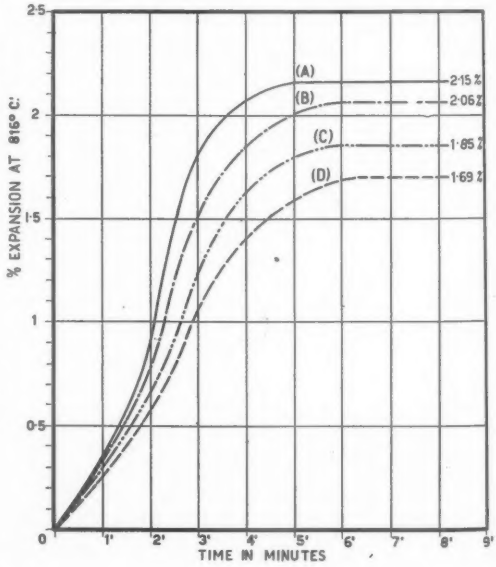
As has already been mentioned, all deliveries of metals, whether in ingot or billet form, are given an analytical check. All alloy scrap is carefully selected. Notwithstanding these precautions products of the melting furnaces must be tested and every change in composition noted. It is well known that aluminium alloys (especially those which are to be given heat-treatment) are very sensitive to small variations in composition.

Quantometer estimations are carried out for the principal alloys. Fig. 18 shows the Quantometric determination of the principal elements in an Al/Si alloy. Some 40 samples of aluminium alloys are analysed every day and some 280 individual elements are determined. Certain other alloys are examined spectrographically and of these some 210 elements are determined daily. The total number of elements determined each day by spectro-chemical means amounts to about 500.

## V—X-RAY TESTS

The X-ray laboratory is well equipped and has a number of instruments of different penetration.

FIG. 11.—*Expansion diagrams for moulding sands of various compositions (expressed as percentage of 2-in. specimen).*



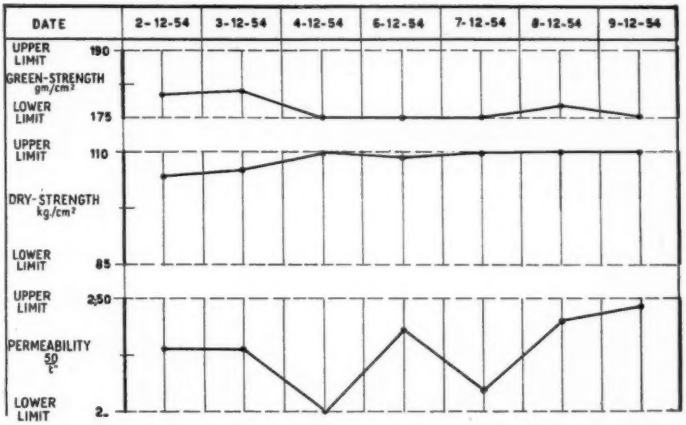



FIG. 12 *(Right).—Characteristics of the core mix selected for standard production.*

FIG. 13.—*Wedge-shaped cast-iron test-piece.*

X-ray tests of aluminium castings are conducted along the following lines:—

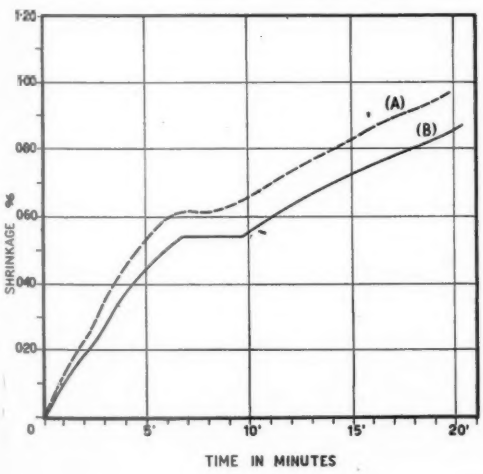
100 *per cent. testing:*—For castings of non-mass-produced engines; for all new castings, and for all castings where the nature of the alloy is changed.

*Partial testing:*—For all normal type "A" castings (2 to 3 per cent. of castings tested); for all type "B" castings (1 per cent. of castings tested); for all castings with internal defects discovered in the machine shop. (In which case the castings are held up until they can be given more thorough X-ray inspection.)

The Quality Control department is free to reduce or increase the number of castings to be X-ray tested to suit production requirements.

Only the more important grey-iron and malleable castings are examined by X-ray. Figs. 19 and 20 are X-ray photographs of light-alloy and malleable-iron castings, showing clearly-visible defects. Inspection by direct X-ray projection is simple and economical, but is used only for detecting fairly large internal cavities, because of its limited effectiveness. Cavities of a size down to 8 per cent. of the penetration depth can be detected by direct projection. Some 90 radiographic and 50 radioscopic tests are carried out daily in the X-ray laboratory.

FIG. 14.—*Contraction of two typical grey-irons.*




## VI—MACRO- AND MICRO-GRAPHIC TESTS

*Macrographic testing* of light-alloy castings is done by observing the homogeneity of the structure and the dimensions of the crystals. Simple inspection can reveal the presence of intercrystalline cracks which are due to inadequate feeding during cooling. Visual inspection is also carried out on a percentage of the grey-iron castings which have undergone surface heat-treatment to ascertain the depth to which tempering has penetrated.

*Micrographic testing* is conducted on iron and aluminium-alloy castings to determine the metallurgical constituents. This test is done every time a new type of product is manufactured as a means of checking that castings are free from irregularities in structure, intercrystalline segregations or impurities —particularly at points of change of section and where cooling might have taken place too slowly (Fig. 21).

Micrographic testing is also carried out on grey-iron castings which will be submitted to heavy wear and require a fine graphitic structure in pearlitic matrix (Fig. 22); on ferritic malleable iron to examine graphite in the ferritic matrix; and on pearlitic malleable iron to examine the structure of the graphite in a predominantly pearlitic matrix (Fig. 24).

## VII—PHYSICAL AND MECHANICAL TESTS

### (a) Grey-iron Castings

For normal production control of grey-iron castings, hardness and tensile tests are carried out

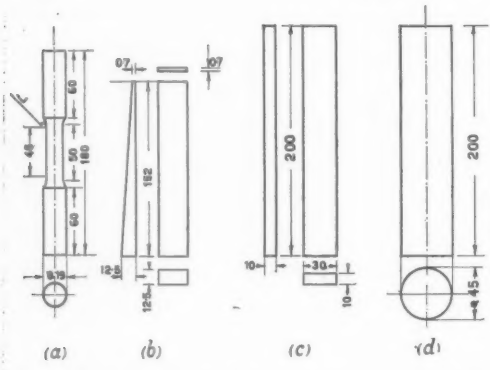


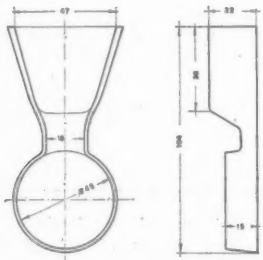

FIG. 15.—*Test-pieces for malleable cast iron; (a) for tensile strength; (b) for dynamic bend test; (c) for static bend test and (d) for pouring test.*

on samples taken at the time of casting. The tensile test-pieces, which have a diameter of 12.5 mm. ($\frac{1}{2}$ in.) (Fig. 25) are also used for hardness testing. This is done on a prepared surface at one of the extremities of the bar. Tensile testing is carried out on unmachined samples, which is not always very accurate, but has the advantage of producing speedy results. In the case of important castings (crankcases and cylinder heads), hardness tests are carried out on the castings themselves. Thorough hardness tests are conducted on all castings, such as camshafts and gears, which have to undergo heat-treatment.

### (b) Malleable Iron Castings

Samples are taken at suitable intervals from every batch of metal and tested for tensile strength, static and dynamic bending (Fig. 15, A, B, C). The samples accompany the castings throughout their heat-treatment cycle, and are tested for tensile, elongation and static and dynamic bending strength. Hardness tests are also carried out on 3 to 15 per cent. of the batches.

FIG. 16.—*Test-piece for Quantometer test (dimensions in mm.).*



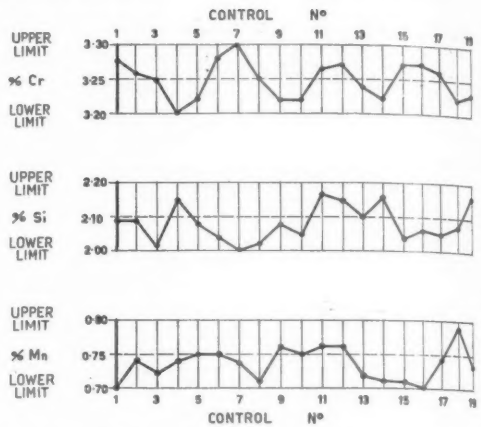



FIG. 17.—*Analytical determination of the principal elements in ordinary grey iron.*

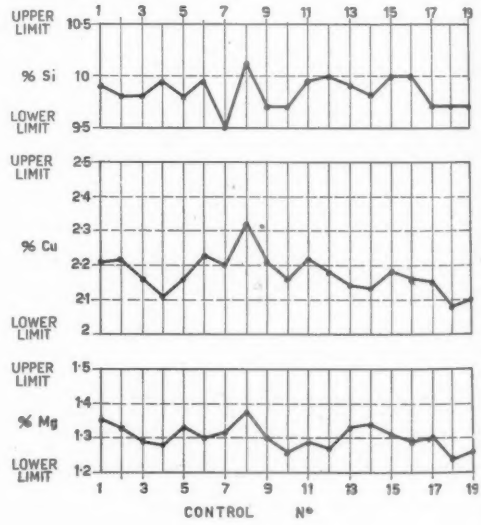
### (c) Light-alloy Castings

Physical and mechanical tests of three degrees of severity are carried out on light-alloy castings. These are listed in Table I.

TABLE I.—*Tests for Light-alloy Castings.*

| Grade of test. | Type of test. | How and when conducted. |
|---|---|---|
| A | Analysis .. .. | During pouring. |
| | Tensile .. .. | On separately-cast samples. |
| | Brinell .. .. | On samples cast after pouring. |
| B | Analysis .. .. | During pouring. |
| | Brinell .. .. | On samples cast after pouring. |
| C | Analysis .. .. | During pouring. |

FIG. 18.—*Daily Quantometer test of light-alloy metal for pistons.*



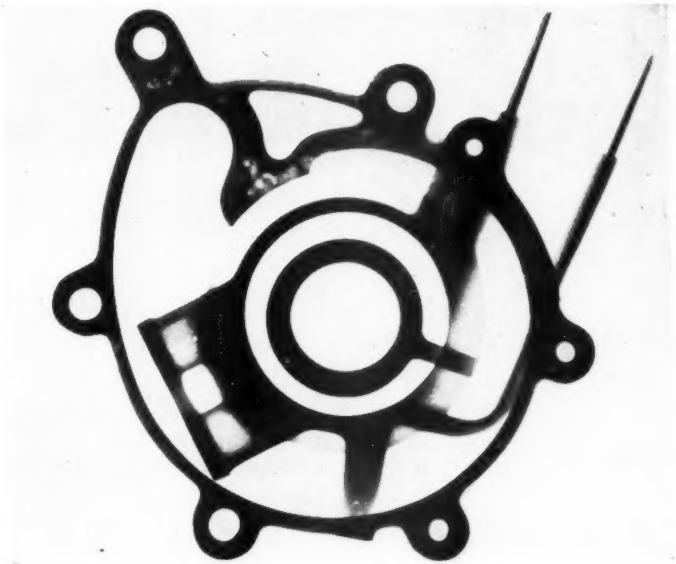


FIG. 19.—*X-ray photograph of light-alloy casting.*

The control of chemical composition, which has already been described, is done during pouring, and samples are taken at regular intervals to see that composition remains within the prescribed limits throughout the day's operations.

*Tensile tests* are conducted on separately-cast test-pieces (Fig. 26), cast under similar conditions to the main castings.

*Brinell hardness* is tested on the castings themselves or on test-pieces cast at the same time.

*Dynamic testing* of actual castings both of malleable iron and light alloys is carried out on all development work where castings have to stand up to severe stresses. These castings are tested to destruction in a well-equipped laboratory.

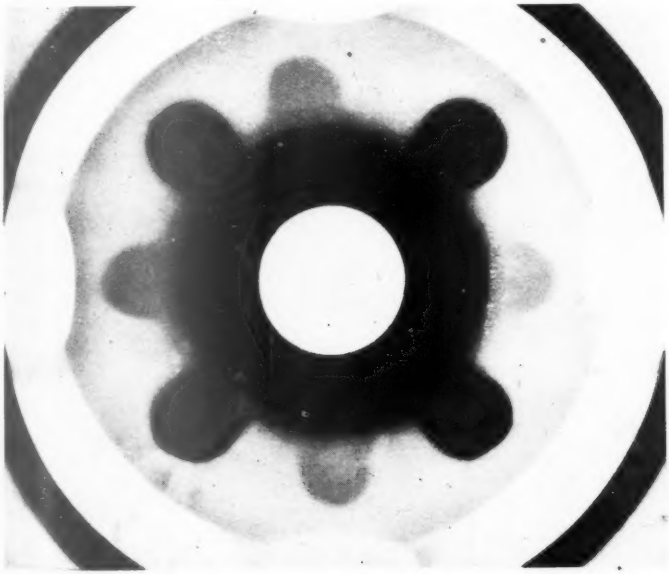


FIG. 20.—*X-ray photograph of malleable-iron casting.*

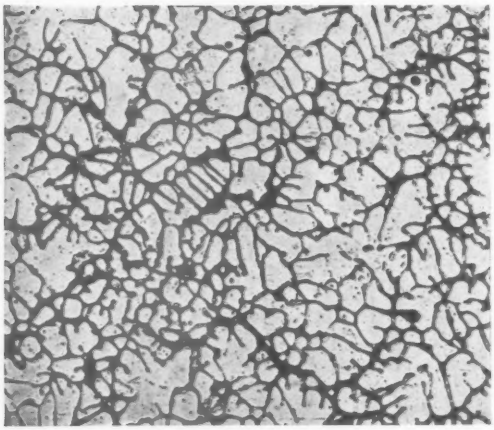


FIG. 21.—*Photomicrograph of a light-alloy casting (etched nitric acid).*

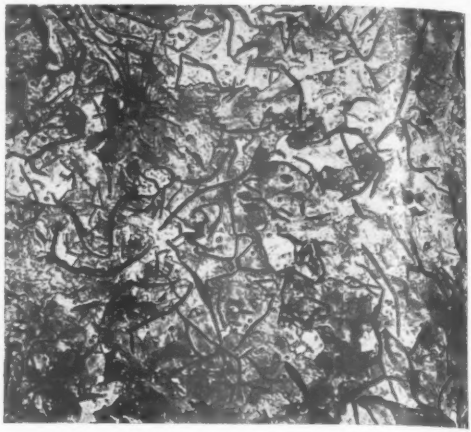


FIG. 22.—*Photomicrograph of a pearlitic grey-iron casting (etched Nital, × 100).*

## CONCLUSIONS

The use of the systematic controls described has produced very satisfactory results. The total percentage of reject castings produced in the first eleven months of 1954, *i.e.*, from January 1 to November 30, are shown in Table II.

TABLE II.—*Average Percentage of Reject Castings Produced in First Eleven Months of* 1954.

| Type of casting. | Per cent. reject foundry defects. | Per cent. reject machining defects. | Per cent. rejects, Total. |
|---|---|---|---|
| Grey and malleable-iron .. .. | 2.6 | 1.3 | 3.9 |
| Light-alloy .. | 3.8 | 1.0 | 4.8 |

When considering these figures it should be remembered that some 260 different types of grey and malleable-iron castings and some 320 types of light-alloy castings are manufactured in the FIAT foundry. The total labour force employed on quality control amounts to 6.8 per cent. of all productive labour.

Statistical methods of quality control have been examined closely by the personnel of the foundry, but are considered to be of limited value in foundries producing a wide range of products. Where they have been adopted in the U.S.A., the United Kingdom and other European countries, they have been used to control quality in light-alloy pressure-

FIG. 23.—*Photomicrograph of a ferritic malleable-iron casting (etched Nital, × 150).*

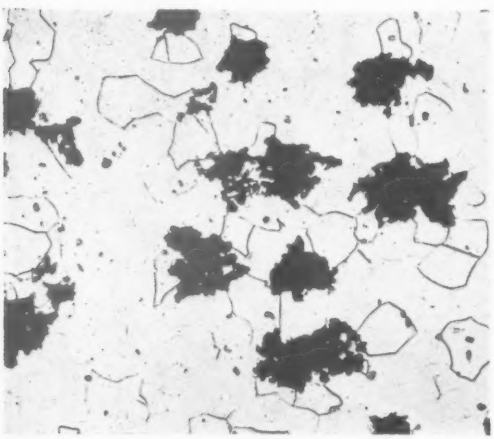


FIG. 24.—*Photomicrograph of pearlitic malleable iron casting (etched Nital, × 100).*

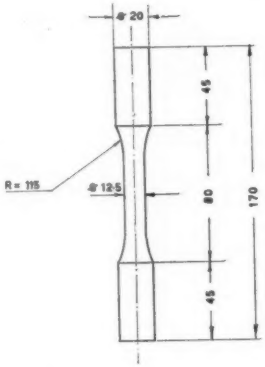



FIG. 25.—*Grey-iron tensile test-piece (dimensions in mm.).*

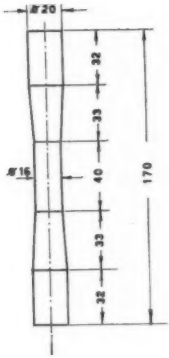



FIG. 26.—*Light alloy tensile test-piece (dimensions in mm.).*

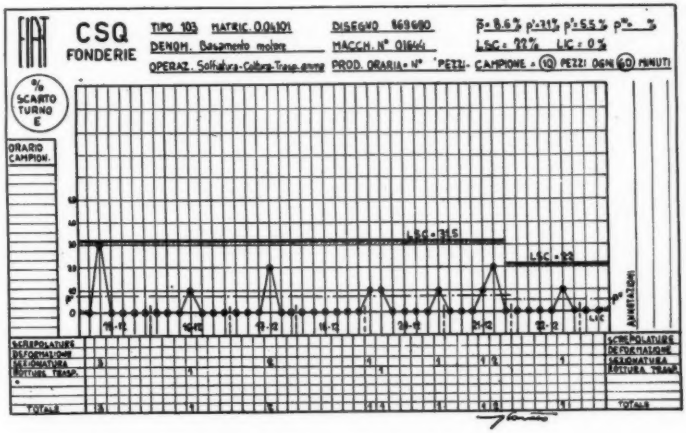



FIG. 27.—*Quality-control chart for the production of motor-car crankcase cores (ramming, baking and transport).*

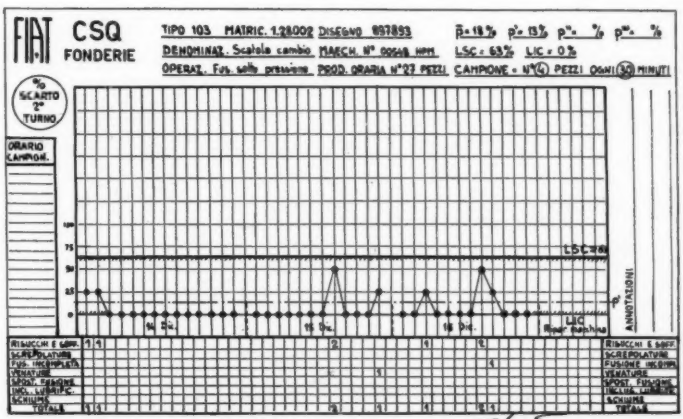



FIG. 28.—*Quality-control chart for the production of motor-car gearboxes (light-alloy pressure-die-casting).*

FIG. 29.—*Quality-control chart for the production of motor-car steering boxes (shell moulded).*

die-casting, where relatively few designs are produced in very large numbers.

High-quality products depend on carefully conducted analyses of metal, core and moulding-sand quality and constant supervision at all stages of manufacture. Automatic addition of moisture and careful choice of binders and other additives play a very important part in assuring uniformity in sand mixtures.

Where control charts can be used (Figs. 27, 28, 29) these have the merit of showing trends and awakening the interest of the workers by recording the quality of their work. They help to develop a sense of responsibility and a spirit of competition which cannot fail to have beneficial effects on production.

## Institute of Vitreous Enamellers

### *International Congress, October 9 to 21*

To celebrate the twenty-first anniversary of the formation of the Institute of Vitreous Enamellers, an international enamelling congress has been organized from Sunday, October 9 to Friday, October 21. It will include a works tour visiting vitreous enamelling works in England and Scotland. The twenty-first annual conference of the Institute and the main centre will be at Leamington Spa where the technical contributions both from this country and overseas will be presented by many well-known technicians. Detailed programmes of the Congress for both delegates and their ladies have been arranged and intending participants should complete a reply form and return it to the secretary (Mr. J. D. Gardom) of the Institute, at Ripley, Derbyshire, not later than September 10.

### Programme

*Sunday, October 9*—2.00 to 5.00 p.m. Registration office and information bureau, Park Lane Hotel, Piccadilly, London, W.1. 7.30 for 8.00 p.m. Reception and inaugural congress dinner at the Park Lane Hotel.

*Monday, October 10*—Works visits to R. & A. Main, Limited, Belling & Company, Limited, and Benjamin Electric Company, Limited, or Electrolux, Limited.

9.00 to 10.30 p.m. IVE Southern section reception at the Park Lane Hotel, Piccadilly, W.1.

*Tuesday, October 11*—9.00 a.m. Coaches leave for Leamington Spa, visiting *en route:* the Pressed Steel Company, Limited, Oxford.

9.00 to 10.30 p.m. IVE Midland section reception at the Royal Pump Room, Leamington Spa.

*Wednesday, October 12*—9.00 a.m. Annual general meeting, Town Hall, Leamington Spa, followed by technical session I and works visits to Parkinson Stove Company, Limited; 11.45 a.m. J. A. Jordan & Sons, Limited; 12.00 noon Thomas De La Rue & Company, Limited, and Sidney Flavel & Company, Limited, coaches returning to Leamington.

9.00 p.m. to midnight. Civic reception by Mayor and Corporation of Leamington Spa, followed by dancing.

*Thursday, October 13*—9.00 a.m. Technical session II in the Town Hall, Leamington, and at 2.00 p.m. technical session III. 6.00 p.m. Coaches to the Riverside Restaurant, Stratford-upon-Avon, for dinner prior to visit to the Memorial Theatre.

*Friday, October 14*—9.00 a.m. Technical session IV (morning) and V (afternoon), Town Hall, Leamington.

7.30 for 8.00 p.m. Reception by the president and chairman at Chesford Grange, prior to congress banquet.

*Saturday October 15*—10.00 a.m. Technical session VI in the Town Hall, afternoon free.

6.00 to 7.30 p.m. President's reception.

*Sunday, October 16*—10.00 a.m. Coaches leave Leamington Spa for Manchester, arriving in the late afternoon; evening free.

*Monday, October 17*—Works visit to John Summers & Sons, Limited, or Richmond Gas Stove Company, Limited. 6.30 to 8.00 p.m. IVE Northern section reception at the Midland Hotel, Manchester.

*Tuesday, October 18*—Congress re-assembles. 10.00 a.m. Coaches leave Manchester, for Morecambe, visiting *en route* English Electric Company, Limited, and Stoves, Limited, evening free.

*Wednesday, October 19*—9.30 a.m. Leave Morecambe for Edinburgh, *via* the Lake District. 7.00 to 8.30 p.m. IVE Scottish section reception, George Hotel, Edinburgh.

*Thursday, October 20*—9.00 a.m. Works visit to Carron Company, or M. Cockburn & Company, Limited.

4.00 p.m. Civic reception by the Lord Provost and Corporation of the City of Edinburgh.

*Friday, October 21*—9.00 a.m. Works visits to Smith & Wellstood, Limited; Mitchell, Russell & Company, Limited; British Aluminium Company, or Grangemouth petroleum refinery. After luncheon (by invitation) delegates will return to Edinburgh (afternoon free).

7.30 for 8.00 p.m. Congress farewell dinner at the George Hotel, Edinburgh.

# British Steel Castings Research Association

*Second Annual Report, covering the period April 1, 1954, to March 31, 1955*

[ABRIDGED]

(*Continued from page 215*)

## MOULDING MATERIALS AND FOUNDRY PROCESSES

### Metal Penetration

The Association's sponsored research at Cambridge University under Dr. T. P. Hoar's supervision (Dr. D. H. Houseman, investigator) into the factors affecting the penetration of liquid metal into sand compacts has been completed. This work has constituted one of the most successful features of the fundamental work sponsored by the Association and has thrown considerable light on the mechanism of sand adherence to the cast surface.

The investigation has established that the penetrating pressure* considerably increases as the degree of ramming increases for both fine- and coarse-grain sand-compacts. Examination of carefully made hand-rammed foundry moulds showed a wide variation in the degree of ramming and a rather low average degree of ramming over the surface. Comparisons between the various mechanical ramming techniques used in foundries showed them to be less effective than hand ramming.

Penetrating pressure is almost proportional to the mean grain-size for coarser sands, but not for fine sands, where sintering, giving enlarged pores, becomes progressively more important as the grain size is reduced. Differences in grain-size distribution around a common mean have little effect on penetrating pressure.

Low binder-contents give low penetrating pressures, owing to relatively poor bonding of the grains. A statistical examination of the possible influence of grain movement in compacted sand mixes on penetrating pressure showed that grain movement is likely to be a factor in lowering penetrating pressure in sand mixes having low clay-contents.

Whilst compacts made from zircon have lower penetrating pressures than those made from silica, zircon strips better due to its greater contraction on cooling, which tears the penetrating probes away from the bulk metal.

Metal penetration is best prevented by washes which sinter at temperatures just below that of molten steel, to produce a maximal amount of viscous liquid. This liquid completely seals the pores and covers the sand grains at the mould face, thus providing a continuous slag barrier which prevents metal penetration.

Washes based on eutectic compositions, providing that the eutectic liquid was viscous, were found to be the most promising. Of the 76 washes (basic and siliceous) examined, only the high-silica, low-alumina washes of compositions (5.5 and 14.4 per cent. $Al_2O_3$) near to the trydymite-mullite eutectics were found to be really effective in producing a clean strip. These washes, when applied in thicknesses of 2 mm. gave results fully equal to those of the best plain silica washes and may be less liable to cracking under practical conditions.

These results have been obtained under laboratory conditions and the extent of their application in practice will be determined by foundry-scale trials either in member foundries or in the Association's experimental foundry.

### Sand Adherence in the Absence of Metal Penetration

Further fundamental research sponsored by the Association at Cambridge (Mr. D. F. McVittie, investigator) is concerned with the mechanism of sand adherence in the absence of metal penetration. The general picture that emerges from this is that sand adherence without metal penetration is promoted by two major factors (*a*) the production of an intimate mechanical bond by oxide penetrating and keying into the solid metal, (*b*) the formation by sand-oxide interaction of strong bonding material (Fig. 2). The phenomenon can take place only after cast metal has solidified. To prevent it the oxidation of solidified metal must be stopped, or a sand that does not interact with the metal oxide to give strong bonding material (or a mould wash with similar properties) must be used, or thermal contraction of the casting during cooling must be sufficient to create a gap between the oxide and the mould. In practice, probably all three preventive factors operate to some extent, either accidentally or by design: where intimate contact of hot oxidized solid metal and the mould is unavoidable through geometrical or gravitational factors, it seems possible that zircon washes may be especially useful. A more detailed summary of the conclusions that have so far been drawn has been published to members and the work is continuing.

### High-temperature Properties of Mould Refractories

Arrangements have been made with Sheffield University for researches to be sponsored in the refractories department under the supervision of Dr. J. White (Mr. J. L. Evans, investigator). Mr. Evans was appointed in October, 1954, and work to date has been of a preliminary nature, including the assembly of apparatus.

Many of the results obtained from a research on mould and core-bonding agents were included in a Paper given at the London International Foundry Congress.

* "Penetrating pressure" in this context is an arbitrary expression used by the investigators to evaluate the pressure necessary to force molten metal into a sand compact under standard conditions.—Editor.

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**Core Bonds**

Foundry trials have been conducted using shark-liver oil as a substitute for normal core-bonding agents. It has been found to give 66 to 80 per cent. of the dry-strength obtained with similar amounts of linseed oil and its foundry properties were satisfactory. It is understood, however, that the supply is limited.

A number of miscellaneous mould-and core-bonding agents have been examined: these include pelleted pitch, sperm oil, cold-setting resins, and a sand conditioner of the "Krilium" type. None of these was found to be suitable for wide application in the steel foundry. Quick-drying core-oils of the type used in the "D Process," one of American and the others of British origin, were also examined in the laboratory; it was found that the British products compared favourably with the American in properties and speed of baking.

Some preliminary laboratory investigations have been conducted on specific aspects of shell moulding. It has been shown that considerable segregation of the resin can occur in moulds made from powdered resin/sand mixes and very little segregation in moulds made from pre-coated sands. The amounts and rates of gas evolution from shell-moulding mixes have been compared with those from normal core mixes and some assessment of the permeabilities, densities and heat-transfer properties of shell moulds have been made.

**Carbon-dioxide/Silicate Hardening of Moulds**

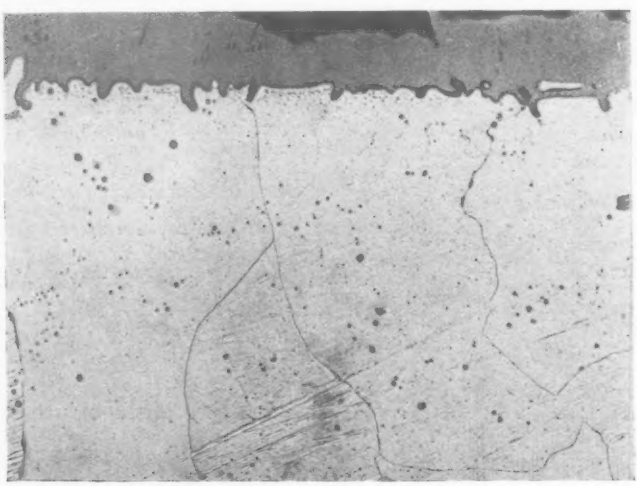
After a survey of published literature and the issue of three translations of the foreign literature on the $CO_2$/silicate process of hardening moulds and cores, the Association has been conducting a preliminary investigation of the bonding properties of proprietary binders and ordinary sodium silicates of different $Na_2O/SiO_2$ ratios. The effect of gassing time, time of standing after gassing and the grain-size of the sand upon the strength properties of the mix have also been investigated. Work is continuing with the aim of producing cheaper and more efficient binders than those at present available and a close watch is being maintained upon any new developments that might arise in connection with this process.

*Sand Reclamation.*—In the $CO_2$/silicate process for hardening moulds and cores, which is gaining increasing application in steel foundries, the used sand is discarded because of the presence of low-melting-point alkalis, which if allowed to accumulate in the sand system would ultimately have a deleterious effect on the refractoriness of the moulding mixture. The problem of sand reclamation, therefore, assumes a particular importance in the further development and application of this process. The Association has, therefore, undertaken trials to determine whether a simple sand reclamation plant of the log-washer type* is capable of reclaiming sand that has been used in the $CO_2$/silicate process. Initial results have shown that it is possible to remove some 78 per cent. of the water-soluble alkali present in the sand by this method of washing. The effect of the residual alkali remains to be determined.

The 1-ton per hour capacity log-washer (Fig. 3) at the United Steel Companies has also been used for reclaiming normal clay-bonded used foundry sands. It has been found possible to remove some

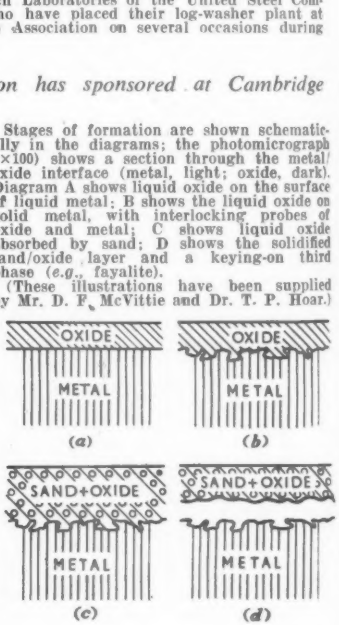
* The Association acknowledges the assistance provided by the Central Research Laboratories of the United Steel Companies, Limited, who have placed their log-washer plant at the disposal of the Association on several occasions during the year.

FIG. 2.—*Aspects of metal-penetration research that the Association has sponsored at Cambridge University.*



Stages of formation are shown schematically in the diagrams; the photomicrograph (×100) shows a section through the metal/oxide interface (metal, light; oxide, dark). Diagram A shows liquid oxide on the surface of liquid metal; B shows the liquid oxide on solid metal, with interlocking probes of oxide and metal; C shows liquid oxide absorbed by sand; D shows the solidified sand/oxide layer and a keying-on third phase (*e.g.*, fayalite).

(These illustrations have been supplied by Mr. D. F. McVittie and Dr. T. P. Hoar.)



10.8 per cent. out of a total of 12.0 per cent. clay-plus-silt fractions present in this type of sand. Whilst the reclaimed sand was not ideal for core-sand purposes—the small amount of residual clay lowering the dry strength when bonded with organic materials—laboratory tests and foundry trials showed it to be a satisfactory replacement for new sand for green- and dry-sand moulding purposes. The economics of the process are to be studied and it is hoped shortly to be able to supply to members some indication of the cost of the plant and the cost of processing the sand. It is anticipated that in the near future pilot-scale trials will be made on a dry, pneumatic-type sand reclamation plant.

**Powder Washing**

Development work relating to the powder-washing process has been continued in two main directions:

(*a*) Provision of suitable powder supplies at economic prices; and

(*b*) Adaptation of the powder dispenser for ease of adjustment and maintenance, as well as improvement of powder-flow conditions.

So far as powder supplies are concerned, while the Association's test on different powders showed that Swedish sponge-iron powder was a satisfactory and cheaper alternative to B.O.C. electrolytic iron powder, the latter has now been reduced in price from 1s. 6d. per lb. to about 8d. per lb. At these prices, it is considered that the process is an economic one for many fettling operations.

All the Association's recommended modifications to the dispenser equipment have now been accepted by the manufacturers, as improvements facilitating regulation of powder flow and maintenance of the equipment (Fig. 4). Trials carried out by the Association using a modified dispenser showed markedly steadier powder-flow conditions. Members have been advised to carry out flow tests on new dispenser equipment before accepting delivery.

**Air-carbon-arc Torch**

After having been successful in persuading a British manufacturer (Rockweld, Limited) to market an air-carbon-arc torch (Fig. 5) of the type that has been in use in the US steel foundries for some years, the Association has, during the year, developed and demonstrated to a large number of members a satisfactory operating technique. Many members are now using this equipment and there is general agreement that for many gouging operations it is superior in speed and conditions of work to the pneumatic chisel. Conflicting reports are being received as to the cracking susceptibilities of different steels when subjected to fettling operations by means of this torch, and this aspect of the subject is now under investigation.

**Moulding-sand Compaction and Moulding Machines**

The BSCRA/Houseman penetration tester, which uses mercury as the penetrating medium, has been used for determining the degree of compaction of moulds made by various foundry moulding techniques. It was found that, of the methods investigated, hand ramming achieved the greatest degree of compaction, and that jolt squeezing was not as effective as impeller ramming. Members carrying out trials with the tester have suggested that the instrument has possibilities as a research tool, but that under foundry conditions the test is no more informative than the simpler mould-hardness test.

A substantial volume of data relating to American moulding machines and their performance was submitted to the Association by the chairman of the plant engineering committee (Mr. R. F. Horton). It has been analysed to ascertain whether it provided any evidence for the widely-held view that moulding machines installed in the US steel foundries produce better-rammed moulds and require less maintenance than British machines. The analysis proved to be inconclusive, not only on account of differences in the types of machine on which data were available, but also because differences in the compaction properties of American and British moulding-sand mixes invalidated direct comparison.

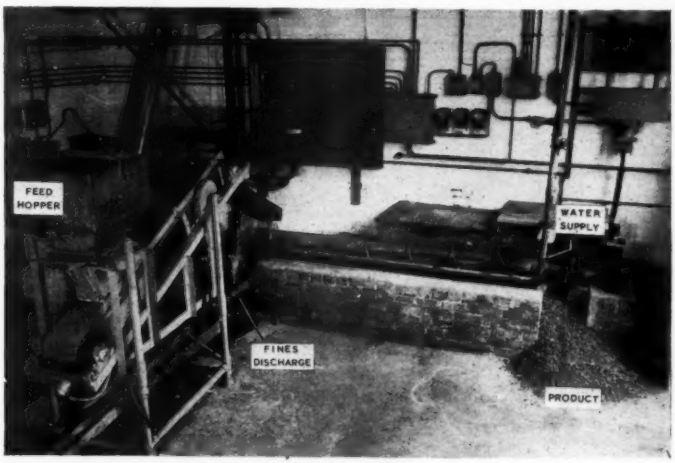



FIG. 3.—*Log-washer plant at the Central Research Laboratories of the United Steel Companies, Limited, which has been placed at the disposal of the BSCRA for trials in sand reclamation. Normal clay-bonded sand has been reclaimed satisfactorily in this plant for use as facing sand.*

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## PROPERTIES OF STEEL CASTINGS

### Low-temperature Properties

This investigation has been undertaken with a view to establishing low-temperature-impact properties of commercially produced steel castings, and in particular to provide a basis upon which future specification requirements may be framed. Following a literature review of the subject made last year, which was based mainly upon American data, tests have been undertaken on a range of carbon and low-alloy steels provided by members, either in the form of clover-leaf or keel-type test-blocks.

The results obtained on the carbon steels have been reported to members. These have indicated the V-notch transition curves for each steel in various conditions of heat-treatment, and an assessment has also been made of the temperatures to give 15 ft. lb., using the keyhole notch, the test figure called for at the service temperature in most American specifications for steels required to operate at low temperatures.

The work reported on the carbon steels has confirmed that, for the purpose of developing the best low-temperature-impact properties, castings should be normalized following a full annealing treatment. On the other hand, where only a single heat-treatment is to be applied, normalized material has been shown to give markedly better properties than material in the fully-annealed condition. The mean temperatures at which a 15-ft. lb. impact figure has been obtained in the normalized condition, on test material supplied by three different foundries, are indicated in Table 1.

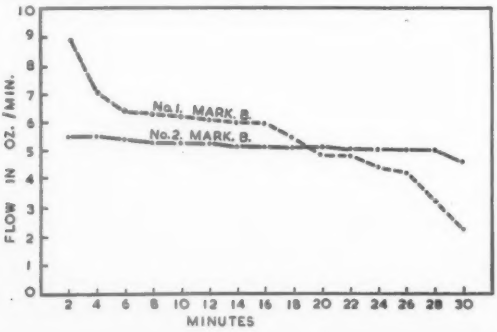
TABLE I.—*Mean Temperatures at which 15-ft.-lb. Impact Energy is Obtainable in Carbon Steels in the Normalized Condition.*

| Steel. | Supplier. | Temperature (deg. C.) to give 15-ft. lb. | |
|---|---|---|---|
| | | V-notch. | Keyhole notch. |
| Low-carbon .. .. | Foundry A and C .. | −40 | −80 |
| (0.15-0.20 per cent. C) .. | Foundry B .. .. | −60 | −100 |
| Medium-carbon .. .. | Foundry A and C .. | 0 | −10 |
| (0.30-0.35 per cent. C) .. | Foundry B .. .. | −25 | −50 |

The figures quoted in Table I relate to steels produced in the basic electric-arc furnace, finished with a ladle addition of 2 to 2½ lb. per ton of aluminium.

Interest in this programme must, however, mainly centre on the work in hand on the low- and medium-alloy steels, tests upon which form the major part of this particular project. A large range of alloy steels is included in this programme in which the V-notch transition curves are being determined for material in various conditions of heat-treatment and at various tensile levels. The major part of the experimental work involved is now completed and an interim report is in course of preparation.

The Association takes this opportunity of acknowledging with thanks the valuable assistance provided by the Armament Research and Development Establishment, Woolwich, who have carried out most of the low-temperature impact tests, and by Imperial Chemical Industries Limited, Billingham, who have carried out certain of the impact tests on the carbon steels.




### Magnetic Properties of Cast Steel

This investigation is aimed at determining the precise influence of heat-treatment on the magnetic permeability of cast carbon steels of differing carbon content. In particular, the in-

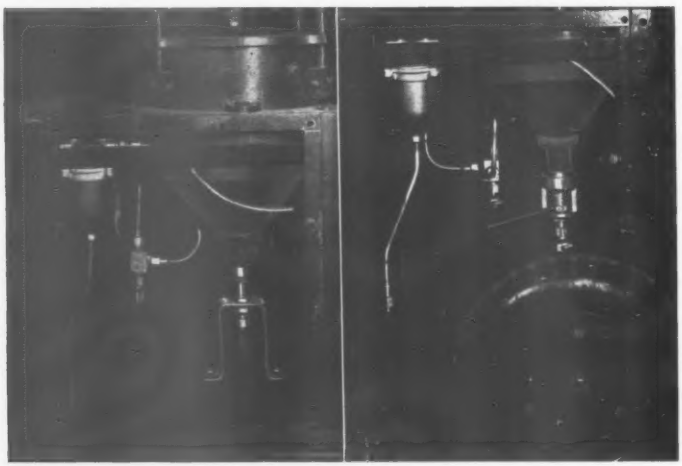


FIG. 4.—*Development work carried out by the Association using standard powder-washing equipment indicated modifications that could be made to improve stability of flow at economic flow rates. The photographs show (left) the old and (right) the new method of mounting the powder injector, the curves show the more stable flow rate that was achieved with the new (No. 2) dispenser.*

fluence of annealing as against normalizing, or normalizing and tempering, is being investigated. For this purpose, five high-frequency heats made by William Beardmore & Company, Limited, melted from the same low-carbon scrap and recarburized to levels ranging from 0.09 to 0.35 per cent. carbon, have been cast into test-blocks. Full hysteresis curves for these steels, in the conditions of heat-treatment mentioned, have been prepared, and the results are the subject of a report now in course of preparation.

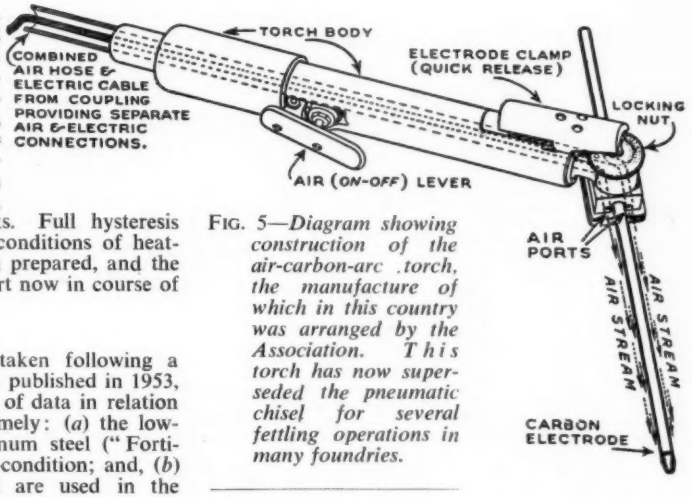



FIG. 5—*Diagram showing construction of the air-carbon-arc torch, the manufacture of which in this country was arranged by the Association. This torch has now superseded the pneumatic chisel for several fettling operations in many foundries.*

### Boron-treated Steel Castings

This investigation was undertaken following a review of the subject which was published in 1953, and has in view the preparation of data in relation to two types of boron steel, namely: (*a*) the low-carbon, 0.5 per cent. molybdenum steel ("Fortiweld") used in the normalized condition; and, (*b*) various low-alloy steels which are used in the hardened-and-tempered condition.

The programme on "Fortiweld" is intended primarily to determine the extent to which the tensile, impact and magnetic properties of this steel may be reproduced in castings manufactured to commercial standards. It is also hoped to study the consistency with which the properties are maintained in relation to the mass of the section as normalized, and to establish data on low-temperature impact strength, in both of which fields, data on "Fortiweld" are lacking.

The programme in relation to the low-alloy hardened and tempered steels, is aimed at comparing the effect of mass upon four low-alloy boron-free steels with its effect upon the same steels in the boron-treated condition. The compositions chosen for investigation are the 1½ per cent. manganese-steel (B.S.1456), the 1½ per cent. manganese/molybdenum steel, the 1¼ per cent. chromium/molybdenum steel (B.S. 1504—621), and the 1½ per cent. nickel/chromium/molybdenum steel. It is hoped to undertake a limited number of low-temperature impact tests on these materials, with a view to establishing the extent to which the boron-treated steels are effective in replacing the more highly alloyed steels of equivalent hardenability, when used in castings destined for low-temperature service.

All the test material for both parts of this programme has now been cast in the form of clover-

FIG. 6.—*Sulphur and phosphorus effects in acid- and Basic-arc electric-furnace melting.*

A statistical investigation of the influence of steelmaking process upon the tensile ductility of annealed or normalized carbon steel castings, showed that basic electric steels all exhibited significantly better tensile ductility than similar acid electric steels. The diagrams indicate that this cannot be directly attributed to any differences in sulphur or phosphorus content.

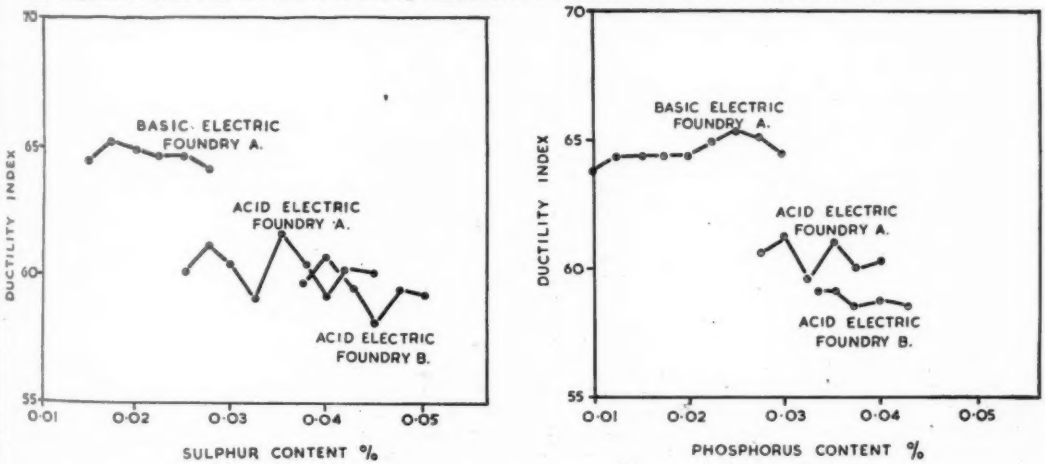


FIG. 7.—*Permanent magnet for crack detection, as designed by the Association for shop-floor use.*

leaf test-blocks, and most of the test-pieces have been prepared. Preliminary tests have indicated that in all cases the boron additions have in general been effectively made.

### Comparison of Tensile Properties of Acid and Basic Steels

This project initially arose from a desire to establish, on a quantitative basis, the extent to which basic electric steels are of superior "quality" to those produced in acid-lined furnaces. Work previously reported had shown that in terms of tensile ductility basic steels were in fact superior to either Tropenas or acid-electric steels, but since the data used for the investigation were in general obtained from steel produced as early as 1950-51, it was suggested that a further analysis should be carried out to include, in particular, acid-electric steel test data of more recent origin. It was felt that advances in acid-electric steelmaking practice, in particular the wider use of oxygen injection, might well be associated with an improvement in metallurgical quality which might reduce, or even eliminate, the difference between acid and basic electric steels hitherto shown to exist.

Accordingly, a further analysis was made of mechanical test results from acid electric steels produced in 1953 by two different member companies. The results have shown that, whatever improvements in acid-electric practice may have taken place since 1950-51, the conclusions of the earlier report do not require modification. In order to facilitate comparisons between steels of differing carbon content and differing tensile level, a hypothetic measure of quality, termed "tensile ductility" has been employed, and by this means it has been shown that annealed or normalized 0.18 to 0.35 per cent. carbon steels, produced either in the Tropenas converter or in the acid-electric furnace, exhibit tensile elongation figures which are in fact, on the average, only 85 per cent. of those exhibited by similar steels produced in the basic-electric furnace. It has likewise been confirmed, on somewhat better statistical grounds than before, that this difference between steels of acid and basic furnace origin cannot be directly attributed to differences in sulphur and phosphorus content (Fig. 6), and that any influence which these elements may have on tensile ductility, within at any rate the limits encountered in practice, is overshadowed by other process variables.

This latter conclusion must of course be carefully interpreted, and should not be taken to imply that the investigaion has shown that the importance normally attached to restriction of sulphur and phosphorus content is necessarily unjustified. Tensile ductility is only one measure of steel "quality," and where, for instance, notched bar impact tests are called for, the best figures can undoubtedly only be obtained by maintaining a low sulphur content. Furthermore, in the event of the use of an unsuitable deoxidation practice giving rise to Type II inclusions, the fall in tensile ductility will undoubtedly be more marked when the sulphur content is on the high side.

### Portable-magnet Crack-detector

A number of crack detectors to the BSCRA design have been supplied to those members who responded to the Association's offer to arrange for the manufacture of a limited quantity (Fig. 7).

## STEEL MAKING

### Ladle Design

This project as originally planned aimed at a standardization of capacities and dimensions of ladles for steelfoundry use. Later the scope of the project was widened to embrace other factors of ladle design and construction, particularly those concerning safety. A radiograph of a section of a steelfoundry ladle lifting-eye (Fig. 8) revealed that it had been constructed in three parts and welded. Not only were the welds incomplete, but the cavities would act as potent stress raisers under service conditions. The Association has now completed a draft specification for steelfoundry ladles, up to 10 tons capacity, including both dimensional and safety requirements, as a basis for negotiation with manufacturers.

### Oxygen Injection

Following the survey made in 1953 of the practice of oxygen injection in companies represented on the steelmaking committee, a wide divergence in oxygen requirements as measured by the specific

oxygen consumption was revealed, and gave rise to serious doubts concerning the accuracy of flow-measuring instruments employed. An examination of alternative metering equipment was therefore carried out, with particular reference to recording and integrating types of instruments. A meter capable of assessing and recording with sufficient accuracy flow-rates and volumes encountered in oxygen-injection practice is now being obtained and with improved equipment it is proposed to carry out a further survey with the ultimate object of ascertaining the slag condition and bath temperature conducive to the most economic use of oxygen.

Consideration has also been given to the possibilities of further economy by using oxygen of low purity or oxygen-enriched air, or compressed air and inert gases for carbon, phosphorus and sulphur removal. Investigations of these possibilities are contemplated.

### Ladle Stoppers

Liaison between members and manufacturers in relation to ladle-stopper design and quality has been maintained. As a result, quality control by the manufacturers has been intensified and general improvement in uniformity and quality of supplies is reported.

### Rammed Furnace Roofs

The examination and mixing of British clays suitable for use as rammed linings for furnace roofs is proceeding under the direction of Dr. J. White at Sheffield University. A few trial roofs made of a proprietary ganister mix by one member showed a very limited degree of success. Further trials on complete roofs by this member have been discontinued and future trials will initially be confined to the centre section of the roof between the electrode ports. This ganister material appeared to contract considerably in service, giving rise to cracking, leakage and ultimately to failure.

### Electric-arc-furnace Refractories and Practice

A survey of refractory and general practice in 19 (17 basic, 2 acid) electric-arc furnaces of rated capacities up to 15 tons has shown:

(1) That the rammed, dry-dolomite type of hearth is more economical than the rammed tarred-dolomite hearth.

(2) That the life of silica roofs is greater when the thickness of the roof is 9 in. rather than 13 in.

(3) That the wear of sidewalls varies considerably from furnace to furnace for the same type of refractory material.

Further survey work is being planned, particularly with regard to fettling practice and the economics and practice associated with the use of "magnesite tubes" in basic-electric-arc furnace sidewalls.

The data on electrode consumption arising from the survey were subjected to statistical analysis and were published in *Research Report* No. 29, "A Statistical Analysis of Graphite Electrode Consumption in Electric Arc Furnaces." It was concluded from this work that a reduction of the surface area of electrodes exposed in the furnace, made by using electrodes of smaller diameter, is effective in reducing both electrode and electrical consumption.

## INDUSTRIAL HEALTH

### Swing-frame Grinding Machines

Investigations on the BSCRA integral exhaust system for swing-frame grinders have been continuing to perfect the design and maintain the dust control efficiency of the system under a variety of operating conditions which are likely to be met with in practice. An exhaust system that effectively controls the fine dust that is ejected tangentially from the rear of the wheel (the primary dust-stream) and prevents the egress of dust from the front of the wheel guard (the secondary dust-stream) has been developed.

The design of an exhaust hood for a grinding wheel of 16-in. dia., operating at a peripheral velocity of 900 ft. per min. is shown in Figs. 9 and 10. It consists essentially of an extension of the wheel guard, which is connected to the dust collector through a flexible hose. The underside of the hood extends sideways and towards the back of the machine, thus forming a flange in which two intakes are provided. The gaps between the side plates of the hood and the sides of the grinding wheel are reduced to a minimum. A minimum

[Courtesy Edgar Allen & Company, Ltd.

FIG. 8.—*Radiograph of a ladle lifting-eye showing defects in its construction.*

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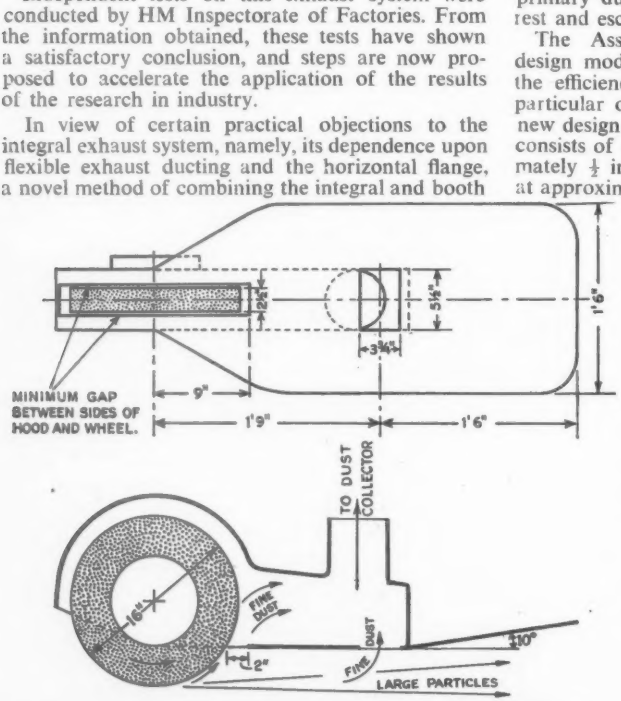
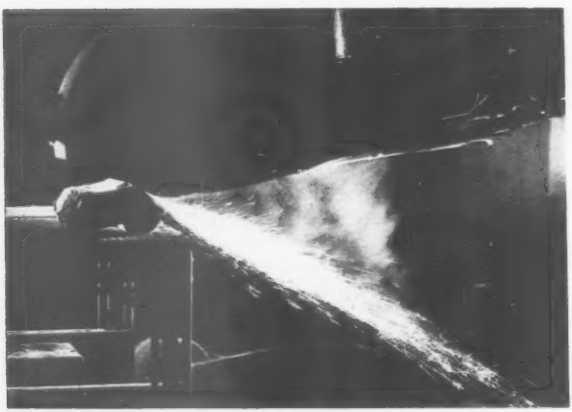
exhaust rate of 900 cub. ft. per min. at 3¼-in. w.g. static pressure is required to control the fine dust generated during grinding of steel castings.

As in the case of the Association's research into the problem of dust control on stand-grinder machines, the system developed for swing-frame grinder dust control has been designed so that it may be applied quickly and cheaply to existing as well as to new machines.

Independent tests on this exhaust system were conducted by HM Inspectorate of Factories. From the information obtained, these tests have shown a satisfactory conclusion, and steps are now proposed to accelerate the application of the results of the research in industry.

In view of certain practical objections to the integral exhaust system, namely, its dependence upon flexible exhaust ducting and the horizontal flange, a novel method of combining the integral and booth system has been evolved and is now in course of development.



FIGS. 9 AND 10.—*A simple and cheap means of providing dust control on swing-frame grinding machines. Existing machines may readily be converted to embody this system.*

Details of the modifications to the wheel guard that are required are shown in the sketch Fig. 9 while Fig. 10 illustrates the effectiveness of the system in controlling both the fine dust carried in the spark stream to the rear of the wheel, and the secondary stream that is normally carried round the wheel to be emitted immediately in front of the operator.

**Stand Grinders**

Arising from the application in practice of the BSCRA modifications for improved dust control on stand grinders, it has been observed in members' foundries that a common practice is to grind castings at a point some distance up the wheel. In these circumstances there is a deterioration in the efficiency of the dust-control system, some of the primary dust-stream being deflected by the work-rest and escaping into the shop atmosphere.

The Association has investigated the further design modifications that are required to maintain the efficiency of the exhaust system under these particular operating conditions and has evolved a new design of roller-type work-rest (Fig. 11), which consists of a grating formed by steel rods (approximately ¼ in. dia.) mounted parallel to each other at approximately ⅝-in. centres and at right angles to the face of the grinding wheel. Tests at the dust-research station and subsequent trials under foundry operating conditions have shown that, when using this design of work-rest, dust control is as satisfactory when the point of grinding is relatively remote from the work-rest as when it is close to it. Problems have arisen in developing a sufficiently robust form of construction; these are now being pursued.

Preliminary trials were carried out on the application of compensating air into the exhaust system on stand-grinder machines in order to lessen the amount of heated air taken from the building. These trials have indicated that the arrangement would have to be considered separately in almost each individual case and to date does not appear to be practicable.

**Dust Collectors**

In conjunction with members of the plant engineering committee, the Association has obtained detailed information upon a large number of

different types and makes of dust-collector systems, some of them novel to steelfoundry applications. The accumulation of these data is a logical preliminary to a comparative study of the efficiency of the equipment. The problem of developing an acceptable method of assessing efficiency is under active consideration. Practical suggestions for improving dust-disposal conditions have been made in discussion of this problem with the plant engineering committee; these suggestions have been published.

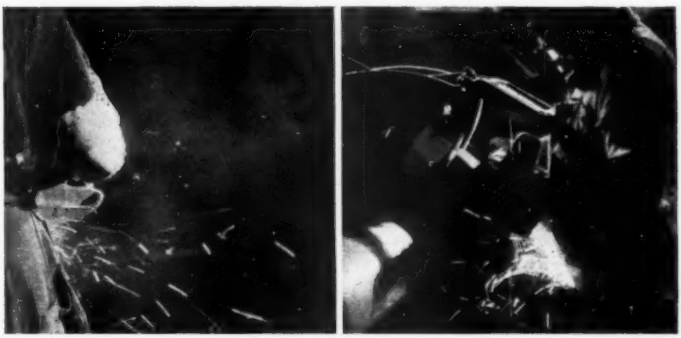
**Atmospheric Dust Concentrations**

It is now widely accepted that the pathogenic action of silica-dust particles in the lung is due to their solubility, which gives rise to localized concentrations of silicic acid. This conception of silicosis strongly suggests that a measurement of dust concentration based upon the surface area of the inhaled dust, will be related more directly to the health hazard than will be a measurement of particle count or mass concentration, a view supported by much experimental evidence.

The Association has accordingly built a dust-sampling instrument (Fig. 12) designed to take long-term samples for assessment by means of the nephelometric method developed by Dr. P. F. Holt. The equipment is operated by compressed air and incorporates an elutriator designed to simulate the dust-retaining characteristics of the upper respiratory tract, so that the filter sample finally estimated includes only those particle sizes which would normally reach the alveola of the lung. The sample is collected on an organic-base filter, which is subsequently dissolved in acetone, the dust remaining in suspension then being measured by nephelometric means, that is, by an optical technique that measures cloudiness in a liquid. Apart from providing what is probably a better measure of the true dust-hazard, this method promises to be far quicker and more convenient than methods taking samples for either visual or automatic counting. If this development proceeds as anticipated, it is estimated members installing such equipment would find that one of their chemical laboratory staff could collect a shift sample and carry out the necessary estimation in approximately half an hour.

**Air-feed Mask**

Further tests have been carried out on a modified version of the mask (Mark III), in which the hood had been extended downwards over the mouth in order to provide a higher degree of protection for mouth breathers. These tests have indicated a protection efficiency of 95.8 per cent. for a breathing rate (through the mouth) of 1 cub. ft. per min. and a supply rate of 3 cub. ft. per min., the test conditions referred to in the earlier report.



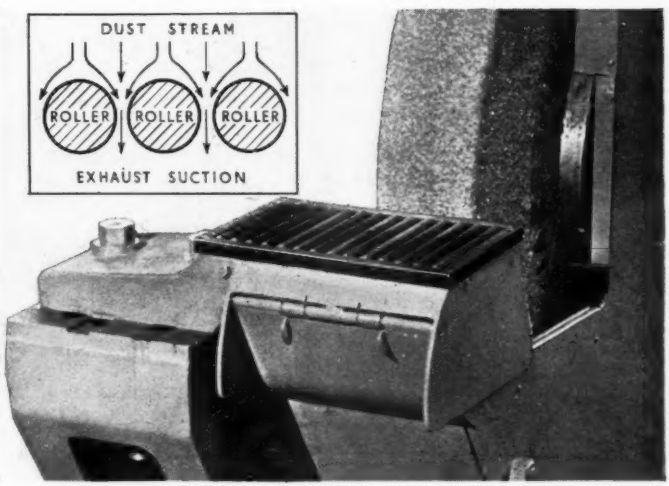



FIG. 11.—*The perforated work-rest for stand grinding machines, originally proposed by the Association for improving dust control on pedestal grinding machines, has been found to be not fully effective when castings are ground at a point some distance above the work-rest, as is illustrated top, left. A roller type of work-rest (lower illustration) has now been evolved and tested in practice which satisfactorily overcomes these difficulties (as shown, top right). Not only does this form of construction offer improved dust control, but the apertures are self-cleaning. First indications are that it has longer life under production conditions.*

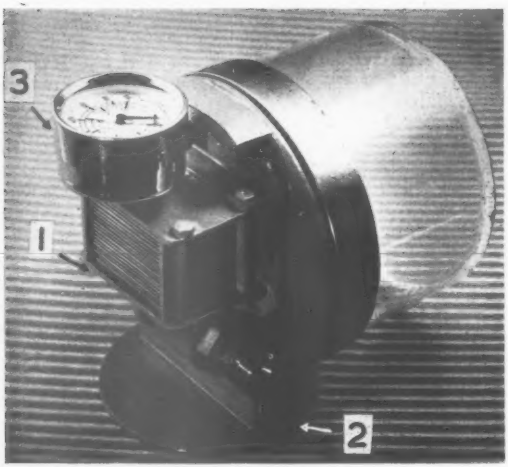



FIG. 12.—*Prototype dust-sampling equipment, designed in the course of an investigation into the best methods for carrying out environmental dust surveys in foundries.*

(1) Dust Elutriator; (2) Air Ejector (to provide air flow through filter); (3) Vacuum Gauge (to check pressure drop across critical flow orifice).

It has thus been shown that a suitably designed air-feed mask can be made to provide a high degree of protection against the inhalation of airborne dust, whether breathing is by mouth or by nose. This project has therefore reached a stage at which potential manufacturers of the mask may be brought in and invited to take over further development. It is now considered that this requires the experience and facilities of a firm specializing in the production of respiratory equipment.

In order to explore the requirements which might govern the approval of the mask by the Factory Department, the Mark III prototype has now been submitted to the Department for testing purposes. Testing of the mask has actually been delegated to the Safety in Mines Research Establishment in Sheffield, who will report to the Factory Department, not only upon the actual efficiency of the prototype submitted, but also upon their own views as to the requirements which the Factory Department might reasonably call for in granting their official approval to the production model. This information will obviously be of vital importance to the firm undertaking the manufacture of the mask.

### Cause of Silicosis in Steel Foundries

Fundamental research has continued at the University of Reading under the supervision of Dr. P. F. Holt. A Research Report on "The Effect of Silicic Acid on Tendon Stability" has been issued, in which further evidence is produced in support of the theory that silicic acid, as produced in the lung from dissolving silica dust, promotes the formation of pathological fibrous tissue in a manner analogous to certain naturally secreted chemicals, which are known to be responsible for the growth and stability of normal fibrous tissue.

By treating normal fibrous tissue, in the form of rat-tail tendon, with hyaluronidase and so removing the stabilizing influence of the mucopolysaccharides the changes occurring in the tissue on alternate immersion in saline and water were observed, both microscopically and by measurement of the shrinkage temperature. The changes observed were both marked and reversible. On treatment of the tissue with a polymerized silicic-acid solution, its stability was immediately restored, no further changes being observed on alternate immersion in saline and water.

From this, it is inferred that silicic acid, as produced in the lung from dissolving silica dust, is capable of behaving in a similar manner to the mucopolysaccharides secreted in other parts of the body, and to which the growth and stability of the healthy fibrous tissues in these areas has been attributed. Work has also continued on the chemistry of silica surfaces and a Research Report covering this work is in course of preparation.

The Report is signed by Mr. C. H. Kain, the chairman, and Dr. R. J. Sarjant, the director of the Association.

## Exports of Coke and Patent Fuel

The following table gives figures of exports of coke and manufactured fuel from the United Kingdom during July, and the total for the first seven months of this year, compared with the same period of 1954.

| Product. | Month ended July 31. | Seven months ended July 31. | |
|---|---|---|---|
| | 1955. | 1954. | 1955. |
| | Tons. | Tons. | Tons. |
| Gas coke .. .. .. .. | 45,494 | 273,486 | 395,599 |
| Hard coke .. .. .. .. | 54,202 | 207,665 | 392,380 |
| Breeze .. .. .. .. | 42,411 | 230,052 | 306,406 |
| Manufactured fuel .. .. | 13,279 | 134,678 | 139,027 |
| TOTAL .. .. .. | 155,386 | 845,881 | 1,233,412 |

## India Accepts UK Steel Mission's Report

Representatives of a United Kingdom group of equipment and construction companies are to be invited by the Indian Government to discuss the installation of a new steel plant in India. This follows the Government's acceptance of the report of the British steel mission which visited India in April, under the leadership of Sir Eric Coates.

The mission put forward proposals for the construction of a plant with an annual production of 1,000,000 ingot tons which would cost about Rs.1,000,000,000 (about £82,000,000). Products of the plant would include sections, billets, railway stock parts, and pig-iron.

India recently signed an agreement with the USSR for the construction of a steel plant in Central India and the German Krupp concern is building another plant at Rourkela, 260 miles west of Calcutta.

# Application of Sub-sonic Vibrations during Solidification of Castings with Particular Reference to a Material for Gas-turbine Blades—" H.R. Crown Max "

*Report No. 89, bearing the title " Application of Sub-sonic Vibrations during Solidification of Castings with Particular Reference to a Material for Gas-turbine Blades—' H. R. Crown Max '," by Mr. S. Hinchliff, D.C.Ae., and Mr. Josiah W. Jones, M.Sc., has been issued by the College of Aeronautics, Cranfield, and with the permission of the director, the Authors' conclusions are reproduced in what follows.*

## Conclusions

The investigation into the effect of sub-sonic vibrations applied during the period of solidification of the gas-turbine material H.R. Crown Max, proved to be very successful, and it has been shown that by such an application the mechanical properties are generally improved. It has further been shown that both the frequency and the amplitude of the vibrations are contributing factors, and that, of the two, frequency is the more important. With the application of vibration, the grain size is considerably reduced. A more detailed analysis of the results follows, and special reference is made to the pouring temperature of 1,550 deg. C., which is a temperature high enough to ensure the complete filling of complex moulds and thin cavities.

(1) *Effect of Elongation.*—Elongation is improved at the higher pouring temperatures, and the highest value attained (41 per cent. with a frequency of 48 vibrations per sec., an amplitude of 0.005 in., and a pouring temperature of 1,550 deg. C.) is an increase of 26 per cent. of the value in the as-cast condition.

(2) *Reduction of Area.*—The shape of the reduction-of-area curves are almost identical with those of elongation, and the maximum improvement when vibrated is obtained under the same conditions. The increase is 33 per cent. of the value in the as-cast condition.

(3) " *Balanced Impact.*"—With the constant frequency of 23 v.p.s., increasing amplitude does not appear to affect the optimum value of balanced impact at a pouring temperature of 1,520 deg. C. At a pouring temperature of 1,550 deg. C., however, the balanced impact is improved by 10 per cent. of the value in the as-cast condition. Increasing frequency to 48 v.p.s. with constant amplitude increases the optimum value at 1,520 deg. C. by 7 per cent., and at the pouring temperature of 1,550 deg. C. the increase is 20 per cent. of the value in the as-cast condition.

(4) *Tangential Proof Stress.*—Both frequency and amplitude increase the proof stress, frequency having the greater effect. When vibrating at 48 v.p.s. the increase in proof stress is 34 per cent. of the value in the as-cast condition, at a pouring temperature of 1,550 deg. C.

(5) *Ultimate Tensile Strength.*—Here again, the effect of vibration is more apparent at the higher pouring temperatures, and once more the higher frequency of 48 v.p.s. gives larger increase in ultimate tensile strength, where at a pouring temperature of 1,550 deg. C. the increase over the value in the as-cast condition is 16 per cent.

(6) *Uniform Microstructure.*—These considerable improvements in mechanical properties are shown to be associated with the removal of typical columnar crystal structure and the substitution of a uniform equi-axed grain-structure. Contributing to this relation of structure to strength there is doubtless a reduction in porosity and a more uniform distribution of the usual real segregation.

(7) *Chemical Composition.*—Except in the case of a single experiment when a piece of carbon rod fell into the melt and raised the carbon content to 1.53 per cent., there was little change due to melting. The variations were: Carbon, 0.19 to 0.24; chromium, 22.47 to 23.17; and nickel, 11.0 to 11.40 per cent.

(8) *Advantages of the Process.*—The result was obtained without expensive alloying or very intricate and costly equipment. The type of equipment developed or other modifications of the out-of-balance vibrator are robust and can find a convenient place on a foundry floor. It is important to note that the improved tensile strength is not attained by loss of ductility or impact value, but all these properties are augmented.

(9) *Limitations of Work.*—The effect of two frequencies only has been explored and the effect of pouring temperature is predominant. Further work to explore the effect of a range of frequencies at the best casting temperature is desirable. While it is established that this type of vibration has improved the casting properties in this work, it is limited to one type of material and one pattern of fixed dimensions. Further work will need to be done to see if the principle is true for other materials and different sizes and shapes of castings.

**Visit "Stand Fifteen"**
*(Row A, Ground Floor, Grand Hall)*
**Readers are invited to call at the JOURNAL stand when visiting the Exhibition.**

# Engineering & Marine Exhibition

## *Brief Particulars of Stands of General Interest at Olympia, September 1 to 15*

*In last week's issue of the* JOURNAL, *details were given of the stands in the Foundry Section of the Engineering, Marine & Welding Exhibition, and Foundry Exhibition which opens at Olympia, London, to-day. These, of course, only form a part, though this year it is a significant part, of the whole exhibition, which occupies all three halls at Olympia as well as the first-floor galleries, etc. Quite apart from castings and foundry machinery and supplies in the foundry section proper—mainly situate on the ground floor, Grand Hall—there are literally thousands of finished engineering products, having castings as the basis of their construction, all over the exhibition and many of these have potential interest to foundrymen visitors. Particulars of some of these stands are contained in the following paragraphs, though such "briefs" necessarily do scant justice either to industrial stands or to the enormous coverage of the exhibition show.*

METALLISATION, LIMITED (Stand 9, Row W, ground floor, Empire Hall) are demonstrating the metal-spraying process. Anti-corrosive coatings, building up of worn parts and details of many other uses will be available; as well as a special hard-facing process of Spraywelding using special nickel/chrome/boron powders.

THE GAS COUNCIL (Stand 5, Row N, National Hall) are featuring shell-moulding, including a range of metal patterns, moulds and cores produced in gas-fired plants, and photographs of various types of gas-heated installations in use for producing shell moulds. Other displays on the stand cover general heat-treatment; an automatic coke-fired boiler, and induction hardening.

SUFFOLK IRON FOUNDRY (1920), LIMITED (Stand 4, Row Y, ground floor, Empire Hall), are showing their range of 31 different types of Sifbronze oxy-acetylene welding rods and appropriate fluxes, together with the "Demon" light- and general-duty blowpipes and regulators. Technical representatives will be in attendance to discuss welding problems, and literature will be available for distribution.

THE STANDARD AND POCHIN BROS., LIMITED, are showing their P.A.C. uniform pulley-mounted centrifugal fan having a gas-tight seal. This is a high-pressure fan used for conveying pulverized powders, the material actually passing through the fan. The P.X. model, also shown, is employed *inter alia* for furnace and cupola draught and is made in ranges up to 40-in. water gauge. (Stand 13, inner row, National Gallery.)

STEWARTS AND LLOYDS, LIMITED, with associated and subsidiary companies, are exhibiting a selected range of products on a double-deck (Stand 6, Row E, ground floor, Grand Hall). Although the principal display is devoted to boiler tubes and manipulated pipework, steel castings; a wide range of joints and couplings; protective linings and coverings, including glass-tissue wrapping; brass and gunmetal valves and fittings are on show.

IN ADDITION to the Azoflex process for producing high-quality copies of plans, drawings and documents of every kind, Ilford, Limited (Stand 4BB, first floor, Empire Hall), are dealing with requirements encountered in non-destructive testing examination by radiography of castings, welds and assemblies in both light and heavy metals. A comprehensive range of Ilford X-ray films, processing chemicals, and radiographic accessories is also available.

THE STAND (No. 1, Row EE, first floor, Empire Hall) of the Copper Development Association itself is an interesting illustration of the variety of colours and finishes obtainable in copper and its alloys, as it is faced with 7-in. squares of copper, brass and nickel silver. The range of technical publications, issued free by the Association, can be inspected, and staff are in attendance to receive requests for books and to assist with technical queries.

MONSANTO CHEMICALS, LIMITED (Stand 14, centre row, National Hall, gallery), are displaying Silesters used as bonding agents in investment casting and in the manufacture of precision piece-moulds by the Shaw Process. Silesters are also employed as bonding agents for cast refractories and furnace linings. New developments featured will be the use of Sytons for investment casting. Syton C enables stable dip-coats to be readily prepared, whilst the 2X type improves the bond strength of water-based investments.

ONE PRODUCTION of G. A. Harvey & Company (London), Limited, on show (Stand 7, Row M, National Hall) is "Harco" woven-wire cloth in a variety of meshes, gauges and metals. Of special interest to founders are the wire screens used for vibrators. These screens are claimed to give a far longer "life" in service under the most exacting conditions than ordinary mild steel. Other wirework of various kinds being shown takes in machinery guards, radiator covers, pipe guards, lift enclosures, partitions, baskets and carriers.

THE STAND of Lafarge Aluminous Cement Company, Limited (Stand 6, Row BB, first floor, Empire Hall), has been designed to show the principal advantages of using Ciment Fondu and to illustrate the fact that one cement can be used for many different industrial applications including making refractory corrosion-resistant, and ultra-rapid-hardening concretes. It is felt that this stand will have particular interest and appeal to the overseas visitor, especially the refractories user from a country which has little or no firebrick industry of its own.

CROFTS (ENGINEERS), LIMITED, announce that on show for the first time (Stand 3, Row BB, first floor, Empire Hall) among a wide range of the firm's power transmission equipment will be shaft-mounted gear units, variable-speed motor gear units, vertical and horizontal flange-mounting Ritespeed geared motors, a new centrifugal clutch, N.T. internal gear coupling, and a range of flush taper bushings. A demonstration set shows

in a striking manner the ability of the Airflex clutch to deal with misalignment and any irregularities of drive.

THE CENTRAL FEATURE on the stand of G. & J. Weir, Limited (Stand 3, Row F, Grand Hall) is a large flow model of the Weir closed-feed system for ships. By an ingenious method of circulating air bubbles in a fluid in coloured piping the steam and water flow in the system under various conditions is clearly shown passing through the unit. The company's very extensive range of auxiliaries for marine and land use are well represented and a selection of valves for steam and water is also displayed.

BSA POWER UNITS on show at the exhibition (Stand No. 10, outer row gallery, Grand Hall) include all four basic models—120, 220, 320, and 420 c.c. capacity engines. They are of the air-cooled, single-cylinder, four-stroke, side-valve type, and operate on vaporizing oil or power paraffin as well as petrol. All can be supplied with built-in reduction gears giving ratios of 2:1, 3:1, or 6:1, and can be fitted with a centrifugal clutch which gives free engine rotation at crankshaft speeds below 900 r.p.m. and solid drive at speeds above 1,400 r.p.m.

THE CHEMICAL ENGINEERING department of John Thompson (Dudley), Limited, are showing exhibits representative of their work in the field of pickling and acid-recovery plant (Stand 4F, ground floor, Grand Hall). A working model demonstrates a rotary process plant supplied for pickling coiled strip. A full-scale pickling cage used in this plant is available for inspection, together with a measuring vessel and an example of a lead-covered copper coil for steam-heating the acid baths. A model of a complete acid-recovery plant is also on show.

THE PARTICIPATION of the Royal Navy (Stand 9BB, first floor, Empire Hall) in the exhibition includes the following models:—A scale model of HMS Eagle showing the angled deck and the position of the steam catapult; the engine room of a Seaward defence boat; a Rolls-Royce RM 60 gas-turbine as fitted in HMS Grey Goose; an Admiralty standard range I 16-cylinder V internal-combustion propulsive unit; a model of the Napier Deltic 18-cylinder propulsive unit; a Paxman and a Mirrlees propulsion unit; and working models of the mirror-aid to deck-landing device.

ONE OF THE MOST INTERESTING features of any exhibition, particularly in engineering, is the demonstration of new processes and equipment. For this reason, Stand 6, Row C, in the Grand Hall, Olympia, should be a special attraction, as the Consolidated Pneumatic Tool Company, Limited, are staging a series of practical demonstrations of many types of engineering operations featuring portable power tools. These will embrace air-operated equipment powered by an electrically-driven stationary air compressor, including the use of grinders with fabric-reinforced cut-off wheels, Hicycle electric tools, and special-purpose tools.

ON THE NEWTON VICTOR stand (Stand No. 3, Row Y, Empire Hall) Raymax 150 industrial X-ray equipment, a new plant, the first to be designed and manufactured in Great Britain employing gas insulation for both X-ray tube and transformer, is featured. The absence of high-voltage cables, rectifying valves and other ancillaries commend this equipment to those who have occasion to examine metals up to 1½ in. thick on open sites. Other items on the stand are: a desk control for the Newton Victor Raymax 250 (with the latest stepless voltage-control); new equipment for low-voltage radiography; and high-voltage rectifying valves and X-ray tubes of the types used in non-destructive testing.

BROOM & WADE, LIMITED, exhibits (Stand 11, Row B, Grand Hall) include portable and stationary air-compressors and pneumatic tools well covering the requirements of foundrymen. Among these will be examples of the new, lightweight, DCL-compressor range and a new air-operated hand drill, type BWD 120, weighing 7¼ lb., suitable for rotating drills or non-rotating chisels. A special (external) exhibit will be the new "Broomwade" portable rotary air-compressor, delivering 600 cub. ft. of free air per min. at 100 lb. per sq. in. pressure, directly coupled through a gear-type coupling to a 180-b.h.p. C6.SFL Rolls-Royce super-charged diesel-engine running at 1,650 r.p.m.

WELLWORTHY, LIMITED (Stand 23, inner row, National Hall, gallery) are exhibiting pistons of all types and sizes applicable to the marine field, including the "Alfin" bimetallic piston which incorporates an austenitic cast-iron insert molecularly bonded into the aluminium body, giving greatly increased wear-resisting properties in the ring-groove area. A special feature is made of the Alfin piston which is now exclusively fitted to the Napier "Deltic" engine. Piston rings ranging from 6 to 36-in. dia.; special purpose rings; cylinder liners ("wet" and "dry") and the "Wellworthy-Ricardo" superchargers complete the list of major items on view.

AMONG THE "WORKING" EXHIBITS of Atlas Diesel Company, Limited (Stand 4, Row DD, first floor, Empire Hall) will be an MLB air-hoist fitted with swivelling suspension and trolley-locking device. This will be the first time that these Atlas hoist-fittings have been shown in Britain. The locking device prevents the trolley moving as the load is swung and is specially valuable for oblique hoisting operations such as are often encountered in foundries. This hoist is designed to operate at angles up to 30 deg., and to lift five tons. Another new item is the LSS-61 sander and grinder, a pneumatic tool designed primarily for sanding, wire-brushing and cup-wheel grinding. In common with the LSS-81, a heavier machine, the LSS-61 has a high power:weight ratio, weighing only 6 lb.

"ELECTRO-HEAT SERVES THE SHIPBUILDING INDUSTRY" will be the theme of the exhibit of the Electrical Development Association (Stand 48, Grand Hall gallery). Four aspects of electric heating in the industry will be pinpointed by means of photographs supported by display matter giving facts and data relating to improved working due to the use of electricity. Demonstrations will be given on the operation of a mains-frequency heat-generator and actual appliances exhibited will include electrically-heated pliers, ultrasonic soldering iron, and an infra-red heating unit. The stand will be equipped with industrial lighting fittings, in which the illumination will be automatically controlled by electronic light-sensitive apparatus responsive to the varying light conditions prevailing in the exhibition hall.

ON STAND 3, Row G, Henry Wiggin & Company, Limited, will be illustrating the many ways in which their range of high-nickel alloys meet the exacting requirements of industry for materials resistant to corrosion and high temperatures. Among the exhibits will be carburizing boxes, a diesel-engine turbo-blower, exhaust valves of high-performance internal-combustion engines, examples of pyrometer sheathing, cores and dies used in the casting of aluminium-bronze components, and diesel-engine pre-combustion chambers. Colour photographs will show the use of nickel, Monel, Inconel and Corronel B in various types of plant, including pickling. Further pictures will show some of the duties of Nimonic heat-resisting alloys, *e.g.*, for the high-temperature parts of vitreous-enamelling furnaces.

# Company News

B. ELLIOTT & COMPANY, LIMITED, machine-tool makers, of London, N.W.10—The company is raising the annual dividend on the £135,000 ordinary capital from 40 per cent. in 1953-54 to 45 per cent. with a final dividend recommendation of 32½ per cent. in respect of the year ended March 31.

ENGINEERING COMPONENTS, LIMITED—The company has declared an interim dividend of 2½ per cent. on account of 1955 on the £937,500 ordinary stock as increased by last month's one-for-four rights issue of 750,000 5s. shares at 8s. per share. The 1954 payments comprised an interim 7½ per cent. on £250,000 before a 200 per cent. scrip issue, and a final of 12½ per cent. on £750,000.

ASSOCIATED ENGINEERING HOLDINGS, LIMITED—The board announces that holders of 96.03 per cent. of the total share capital of Coventry Radiator & Presswork Holdings, Limited, have accepted the offer to purchase the issued preference and ordinary share capital. The basis was two Associated Engineering ordinary 5s. units for each 5s. ordinary and one new 5½ per cent. £1 preference for every 5 per cent. £1 preference in Coventry Radiator.

DOUGLAS (KINGSWOOD), LIMITED, engine and vehicle manufacturers, etc., of Kingswood, Bristol—The directors have been informed that, subject to certain conditions, a company in the engineering field intends to offer 15s. for each £1 unit of 6 per cent. convertible debenture stock beneficially owned by the Charterhouse Finance Corporation, Limited, 30s. for each other £1 unit of 6 per cent. convertible preference stock, 2s. 6d. for each ordinary 5s. unit, and 9d. for each deferred 2s. unit.

BRITISH OXYGEN COMPANY, LIMITED—Acceptances have been received covering over 97 per cent. of the recent rights issue of 3,247,079 ordinary shares. The number of additional shares applied for was over 15 times in excess of the number available. Applications for additional shares are being allotted as follow:—Up to 9 shares in full; 10 to 100, 10; 101 to 500, 20; 501 to 1,000, 40; 1,001 to 5,000, 50; above 5,000 shares the allotment has been drastically scaled down, with a maximum of 75 shares.

DESOUTTER BROS. HOLDINGS, LIMITED, machine tool manufacturers, of London, N.W.9—The directors have declared an interim dividend in respect of 1955 of 7½d. per 5s. ordinary share, equal to 12½ per cent., payable on October 1 to shareholders registered on September 15. This compares with an interim dividend of 6d. per share, or 10 per cent. for 1954, followed by a 15 per cent. final payment. It is the intention of the directors to declare all future dividends on the ordinary shares expressed as so many pence per share and not on a percentage basis on the paid up share capital.

KIRKSTALL FORGE ENGINEERING, LIMITED—A very considerable financial outlay is involved by the decision of the board to change to oil firing in view of concern regarding future cost and supplies of coal. The conversion is hoped to be completed early in 1956. Mr. R. F. Butler, chairman, points out in his statement with the full accounts to June 30 last, that with continually rising costs of labour and material, etc., profit margins are all the time becoming smaller. However, the order-book is in a very healthy state and the board hopes, by increasing output this year, to achieve results at least as favourable as for 1954-55.

# British and German Steel Prices Compared

Home-trade prices of steel in the United Kingdom and in Western Germany are compared in the following table, published by courtesy of the British Iron and Steel Federation.

Prices are per long ton in each case, are for comparable sizes and qualities, and with the exception of tinplate, are delivered rates.

| Product. | W. Germany | | | United Kingdom | | |
|---|---|---|---|---|---|---|
| | £ | s. | d. | £ | s. | d. |
| Foundry pig-iron (Middlesbrough delivery in UK) | 25 | 16 | 0 | 17 | 1 | 0 |
| Re-rolling billets, 4 in. sq. (100 mm.) | 32 | 9 | 6 | 27 | 9 | 0 |
| Wire rods, 5 s.w.g. (5.5 mm.) | 38 | 15 | 0 | 34 | 3 | 9 |
| Angles, 5 in. by 5 in. by ½ in. (120 by 120 by 12 mm.) | 38 | 17 | 6 | 31 | 2 | 0 |
| Joists, 12 in. web (300 mm.) | 37 | 11 | 0 | 31 | 3 | 0 |
| Plates, 20 ft. by 60 in. by ¼ in. (6,000 by 1,500 by 6.5 mm.) | 45 | 7 | 6 | 35 | 4 | 0 |
| Re-rolled bars, 2½ in. dia. (64 mm.) | 39 | 4 | 0 | 34 | 3 | 6 |
| Reinforcing bars, ⅝ in. dia. (16 mm.) | 36 | 3 | 6 | 33 | 13 | 0 |
| Hot-rolled strip, 3 in. by $\frac{3}{16}$ in. (75 by 4.76 mm.) | 44 | 10 | 0 | 35 | 5 | 6 |
| Sheets, 6 ft. by 36 in. by 20 g. (2 by 1 m. by 1 mm.) | 54 | 16 | 6 | 44 | 5 | 0 |
| Tinplate, 1C 28 in. by 20 in., f.o.t. in UK, at basing point in Germany, per basis box | 4 | 11 | 9 | 3 | 0 | 4 |

# Increases in Capital

ENGLISH ELECTRIC COMPANY, LIMITED, increased by £10,000,000, in £1 ordinary shares, beyond the registered capital of £15,000,000.

WATFORD ENGINEERING WORKS, LIMITED, increased by £100,000, in £1 ordinary shares, beyond the registered capital of £150,000.

KNOWLES TROTMAN, LIMITED, engineers, etc., of London, N.22, increased by £5,000, in £1 shares, beyond the registered capital of £5,000.

THOS. FIRTH & JOHN BROWN, LIMITED, increased by £4,450,000, in £1 ordinary shares, beyond the registered capital of £2,550,000.

METALLURGICAL CHEMISTS, LIMITED, London, W.1, increased by £50,000, in £1 ordinary shares, beyond the registered capital of £50,000.

GILBERT KEEN IRON & STEEL COMPANY, LIMITED, increased by £23,000, in £1 unclassified shares, beyond the registered capital of £4,977,000.

PATTERN MAKERS (ENGINEERING) COMPANY, LIMITED, London, N.W.10, increased by £30,000, in £5 ordinary shares, beyond the registered capital of £10,000.

TILGHMAN'S, LIMITED, engineers, etc., of Broadheath, Altrincham (Ches), increased by £666,000, in £1 ordinary shares, beyond the business of £110,000.

COCKBURNS, LIMITED, engineers, valve and spring makers, of Glasgow, increased by £200,000, in £1 ordinary shares, beyond the registered capital of £50,000.

HAYWARD TYLER & COMPANY, LIMITED, ironfounders, engineers, etc., of Luton, increased by £50,000, in £1 ordinary shares, beyond the registered capital of £350,000.

PETER BROTHERHOOD, LIMITED, engineers and ironfounders, of Peterborough, increased by £350,000, in 10s. ordinary shares, beyond the registered capital of £515,000.

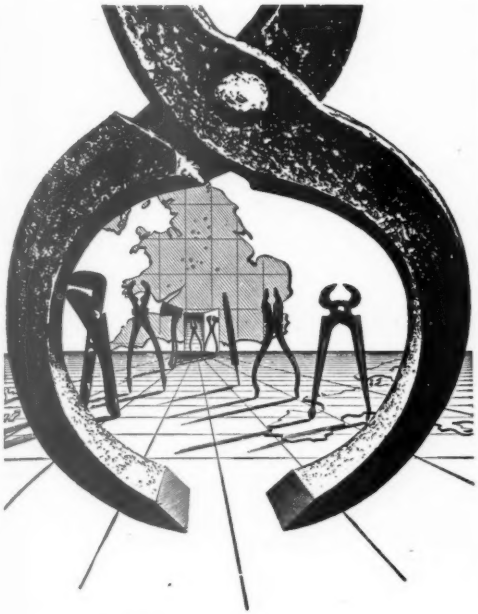
CLARK TAYLOR & COMPANY, LIMITED, colliery proprietors, etc., of Newcastle-upon-Tyne, increased by £30,000, in £1 ordinary shares, beyond the registered capital of £20,000.

# Contracts Open

*The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference ESB can be obtained from the Board of Trade Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, ext. 738 or 771), unless otherwise stated.*

PAKISTAN, September 6—Lead and tin ingots, white metal, and soft solder, for the Director-General of Supply and Development, Lahore. (ESB/17657/55.)

IRAN, September 14—Cast-iron pipes and fittings, and portable saws and drilling machines, for the Procurement Office, US Operations Mission to Iran, Tehran. (ESB/17103/55.)



# Pincer movement

Over a million pairs of pincers and pliers moved out of this country last year. With them went nearly five million files, as many assorted axes, and two thousand tons of hacksaw blades and twist drills.

These export figures for tools are a few out of many. They give some small idea of the world-wide demand for British-made steel products. Last year Britain's toolmakers alone earned £18 million for Britain.

Wherever there is steel there is British steel.

***British steel leads the world***

THE BRITISH IRON AND STEEL FEDERATION

5.93

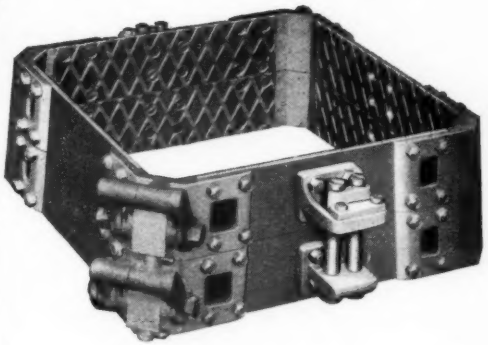
*Introducing*

W. J. Hooker's Revised

**EXTENDIBLE TAPERED**

**SLIP-OFF**

**MOULDING FLASK**



The type of Moulding Flask which the Productivity Teams referred to in their reports after visiting America.

- These Flasks can be supplied with the DOUBLE PINS as illustrated or with the usual single pins. THIS IS AN ENTIRELY NEW FEATURE.
- The size of the Flask can be changed at will.
- They are light, strong and easily handled.
- Can be stored flat in your works eliminating the need to stack your moulding boxes out in the open on valuable space.

Cut this out and send for free leaflet describing Hooker's SLIP-OFF FLASKS.

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**W. J. HOOKER LTD.**

**239a Finchley Road, London, N.W.3.**

**Telephone: Swiss Cottage 3281/2/3**

# News in Brief

PLANS have been approved for the construction of a factory at the Fossway, Newcastle-upon-Tyne, for C. A. Parsons & Company, Limited.

THE TELEPHONE NUMBER of the London office of the British Electro Metallurgical Company, Limited, a division of Union Carbide, Limited, has been changed to LEGation 5361.

A FIRST nine-week course in industrial instrumentation has been completed at the permanent training school established at Perivale, in west London, by Honeywell-Brown, Limited.

TWENTY-ONE EMPLOYEES of Cannon Industries, Limited, gas-appliance makers, etc., of Bilston (Staffs), have been presented with long-service awards. Altogether their years of service total 1,099.

THE Federation of Light Metal Smelters announces that for July its members' average selling prices, to the nearest 10s., were as follow:—LM 1, £186 10s. per ton; LM 2, £189; LM 4, £190 10s.; LM 6, £194 10s.

CORRESPONDENCE received from the Steel Founders' Society of America has printed on the envelope a drawing calling attention to the Society's change of address —to 606, Terminal Tower, Cleveland 13, Ohio.

SIX MONTHS ahead of the contract date the Cross River bridge carrying the principal highway between Nigeria and Central Africa has been completed by Dorman Long (Bridge & Engineering), Limited, Middlesbrough.

A NEW FACTORY costing £A1,000,000 is planned in Australia for Birmid Auto Castings, the Australian subsidiary of Birmid Industries, Limited, Birmingham. Completion is expected towards the end of next year.

INDUSTRIAL DEVELOPMENT CERTIFICATES have been issued by the Board of Trade to 12 firms on Tees-side who are to carry out works extensions. The additions are expected to mean employment for another 456 men and 29 women.

A RANGE of packaging equipment marketed by the Standard-Knapp division of the Emhart Manufacturing Company, of the United States, is to be produced at the Radcliffe factory of Mather & Platt, Limited, engineers, of Manchester.

BECAUSE it can offer the earliest delivery date—December, 1956—either at home or in Europe, Austin & Pickersgill, Limited, Sunderland, has received an order from the Pelton Steamship Company, Limited, for a 4,600-ton motor ship.

VICKERS-ARMSTRONGS, LIMITED, Walker-on-Tyne, has received orders from the Esso Petroleum Company, Limited, for two tankers of 36,000 tons d.w. The propelling machinery will be supplied by the Vickers-Armstrongs works at Barrow.

THE FIRST FACTORY in the Northern Ireland Government's new industrial estate at Carnmoney (Co. Antrim) is to be occupied by the Birmingham Small Arms Company, Limited. The company intends to build up a labour force of from 500 to 600 workers.

GOLMET DOORS, LIMITED, of Caerphilly, Glamorganshire, are showing at the forthcoming building exhibition, to be held at Olympia in November, a line of aluminium-rolling-shutter doors made from a single sheet of high-tensile alloy suitable for installing in garages.

MANUFACTURERS of arc-welding materials and equipment, the Quasi-Arc Company, Limited, and Fusarc, Limited, are to be merged from October 1 in a new company under the name of Quasi-Arc, Limited. Both companies are subsidiaries of the British Oxygen Company, Limited.

THE TRANSFER will begin this month of the Premier Aluminium Casting Company, Limited, from Birmingham to its new premises, costing £50,000, at Birchills, Walsall (Staffs). The transfer should be complete by the end of January and a 50 per cent. increase in the labour force is planned.

JENOLITE, LIMITED, 13-17, Rathbone Street, London, W.1, announce that they have developed and placed on the market a jelly-like mill-scale remover to be applied on site, before painting. Two sorts are available—one for application where the scaling is heavy and the second for normal conditions.

POWER GAS CORPORATION, LIMITED, of Stockton-on-Tees, have established the following five specialized divisions: Blast furnace; general contracts; gas plant; chemical plant; and works division. Mr. D. R. Brown, Mr. C. Ingman, Mr. T. H. Riley, Mr. P. M. K. Embling, and Mr. T. K. Hargreaves are the respective heads.

A NUMBER of prominent industrialists who have visited Germany this year will outline the conclusions they have formed about German industry, at a conference organized by the West Midland group of the British Association for Commercial and Industrial Education, at the Botanical Gardens, Birmingham, on September 6.

A JOINT CONFERENCE on "Automatic Control in the Process Industries" is to be held at Caxton Hall, Westminster, on October 4, commencing at 9.45 a.m. An interesting programme of lectures is to be given. Details are available from the secretary, Society of Instrument Technology, Limited, 184, Sherwood Park Road, Mitcham, Surrey.

THE TWENTY-THIRD American firm to find a home at Scottish Industrial Estates is Aircraft Marine Products, Limited, of Harrisburgh, Penn. The firm, to make electric terminals for aircraft, is taking over a 17,000 sq. ft. factory at Port Glasgow. Up to 100 workers, both men and women, will eventually be employed. The firm's products are the first of the kind to be manufactured in Scotland.

MIDLAND MONOLITHIC FURNACE LINING COMPANY, LIMITED, have just completed a major reorganization of their works, including the opening of additional refractory plant at Wansford. Two main centres of production will now operate at the Duddington and Wansford works, whilst the offices have been transferred to 53, Regent Road, Leicester. The installation of this additional plant has considerably increased their capacity.

NEGOTIATIONS for the building of diesel locomotives in Australia have been completed between Sulzer Bros. (London), Limited, and the Commonwealth Engineering Company, of Granville, New South Wales. The locomotives, which have been designed to meet the special requirements of the Australian railway systems, will be fitted with Sulzer diesel traction engines and will be marketed under the name Comeng-Sulzer. The engines will be fitted to the chassis in Australia.

FIREMEN from Cleckheaton and Heckmondwike on August 23, quickly brought under control an outbreak of fire at the works of Dawson Bros., Limited, bottlers' engineers, Dewsbury Road, Gomersal. The outbreak was confined to the paint-spraying department, where it was believed that a spark from grinding equipment ignited paint vapour which caused an explosion, setting fire to machinery which was in the process of being

(*Continued on page* 40)

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F&M S. Ltd.

# Scientifically developed and controlled Foundry Products

SUPINOL & SUPINEX CORE BINDERS

PARTEX PARTING POWDER & LIQUID PARTING P.L.P.

STOLIT PLASTIC STONE

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*SEE THE DEMONSTRATION OF A SPECIALLY DEVELOPED PLASTIC STONE FOR THE PRODUCTION OF PATTERNS AND PATTERN PLATES FOR USE ON JOLT-SQUEEZE MOULDING MACHINES*

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# Raw Material Markets

## Iron and Steel

There has been a sharp recovery in pig-iron output since June, when production was curtailed by the rail strike. More blast furnaces are working and they are now all operating to capacity limits. Nevertheless, the output of pig-iron still falls short of requirements; although the gap can be narrowed by withdrawals from stock, contracts have also been placed for the import of more foreign iron during the closing months of this year.

The scarcity of pig-iron afflicts the steel and foundry trades alike. Consumers were able to accumulate some iron during the holiday period, but this was only a temporary relief and producers of low- and medium-phosphorus and hematite irons cannot hope fully to satisfy the heavy requirements of the foundries.

A rise of 7 per cent. in the output of crude steel in the first seven months of this year has not been matched by a similar increase in the deliveries of semi-finished material to the re-rolling mills, although their requirements are on a substantially higher scale. Not until the turn of the year did the flood tide of prosperity reach the re-rolling industry, but the boom is now unmistakable. Home business and export orders are now offered in abundance, but a high level of imports of foreign billets, etc., is necessary to keep the mills in full operation. If these can be maintained arrears in delivery may be kept within manageable proportions, but the supply of semis constitutes an ever-present anxiety.

The holidays are over, and after a brief respite for repairs the mills are now restored to full production. They have an enormous volume of orders in hand, and while this circumstance enables rollers to plan their programmes for long periods ahead, there is little scope for the acceptance of further contracts for deliveries before the end of the current year. Throughout this period the indications are that there will be a tight squeeze for supplies, and this despite the fact that imports have been more than trebled in the past 12 months. Very much more steel—particularly flat products—could be sold in the export markets at prices ranging from 15 to 30 per cent. above the home maxima, but makers are adhering to the policy of a general limitation of the tonnages released for shipment overseas.

## Non-ferrous Metals

In the United States the surprise move by Anaconda at the end of last week in raising the copper price by a further 3 cents to 43 cents per lb., with Phelps Dodge promptly following suit, marked the fourth increase in the American price this year. But it has not marked any slackening in the demand for the metal. The shortage of supplies is emphasized by the US Office of Defence Mobilization's decision to postpone deliveries until June 30, 1956, of approximately 26,000 tons to the national stockpile. It is unlikely, however, that this will have much influence in halting the price rise, as the measure concerns delayed delivery. A further setback has been caused by the floods, after the torrential rains following the hurricane "Diane", which swamped a large part of New England's brass industry, where manufacturers were only just recovering from the recent copper strike.

Such activity on the American scene has inevitably brought repercussions in London. On Friday cash copper jumped more than £10 in price to touch a new peak at £383 15s., with three months showing a similar spurt to finish at £377 5s. This week these values were left behind as on Monday a further gain of £9 in cash was registered and a new record achieved when cash changed hands at £395, while three months touched £390.

On Tuesday, however, cash copper touched yet another peak when the settlement price reached £400, while three months metal ranged between £393 and £395. Prices fell away somewhat on the afternoon's trading.

Tin, on the other hand, has been quietly steady on both sides of the Atlantic, with the price tending to fall slowly. Demand for lead is particularly good in the States and the market has a firm appearance here. Zinc continues to be a firmer market on the other side, with galvanizers prominent.

Official metal prices were as follow:—

COPPER, Standard—*Cash*: August 25, £371 to £371 10s.; August 26, £382 to £383; August 29, £392 to £394; August 30, £399 to £400; August 31, £393 to £393 10s.

*Three Months*: August 25, £364 10s. to £365; August 26, £376 to £377; August 29, £388 to £389; August 30, £394 to £395; August 31, £386 10s. to £387.

TIN, Standard—*Cash*: August 25, £747 to £748; August 26, £747 15s. to £748; August 29, £746 10s. to £747; August 30, £745 to £745 10s.; August 31, £745 10s. to £746.

*Three Months*: August 25, £747 to £748; August 26, £747 10s. to £748 10s.; August 29, £746 10s. to £747 10s.; August 30, £745 10s. to £746; August 31, £745 10s. to £746.

LEAD—*Second half August*: August 25, £106 15s. to £107; August 26, £107 to £107 5s.; August 29, £107 to £107 10s.; August 30, £107 5s. to £107 10s.; August 31, £107 to £107 5s.

*Second half November:* August 25, £105 15s. to £106; August 26, £106 to £106 5s.; August 29, £106 5s. to £106 15s.; August 30, £106 15s. to £107; August 31, £106 15s. to £107.

ZINC—*Second half August*: August 25, £89 15s. to £89 17s. 6d.; August 26, £89 17s. 6d. to £90; August 29, £90 to £90 5s.; August 30, £90 5s. to £90 10s.; August 31, £90 to £90 5s.

*Second half November*: August 25, £89 5s. to £89 10s.; August 26, £89 10s. to £89 15s.; August 29, £89 15s. to £90; August 30, £89 15s. to £90; August 31, £89 15s. to £90.

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### Fuel-saving Loans Reach £1,000,000

The Ministry of Fuel and Power announces that the Government loan scheme for industrial fuel-saving equipment has passed the £1,000,000 mark. Approval has been given to loans for schemes estimated to save 90,000 tons of coal a year at a capital cost of about £12 a ton of coal saved. The scheme, which remains open, is for the granting of loans free of interest for the first two years to help smaller industrialists particularly to save coal and attain a higher standard of fuel efficiency.

---

AFTER 30 years' loyal service, Mr. S. E. SMITH, a Northern representative of Pneulec, Limited, Mafeking Road, Smethwick, retired at the end of last month. His successor is Mr. G. G. F. WISEMAN, "Woodneuk," 2, West Balgrochan Road, Torrance, Stirlingshire; 'phone Balmore 417.

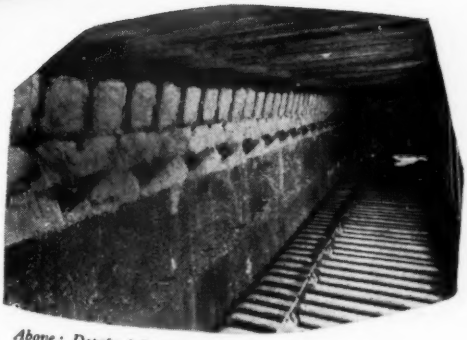
IN THE LIST of exhibitors at the Engineering and Marine Exhibition, published in the August 25 issue of the JOURNAL, page 193, the address of Acme Conveyors, Limited, appeared as 181, Knightsbridge, London, S.W. They have moved from this address and are now at 22, Hans Road, London, S.W.3.

# BOILER BAFFLES

Examples of another of the many uses for

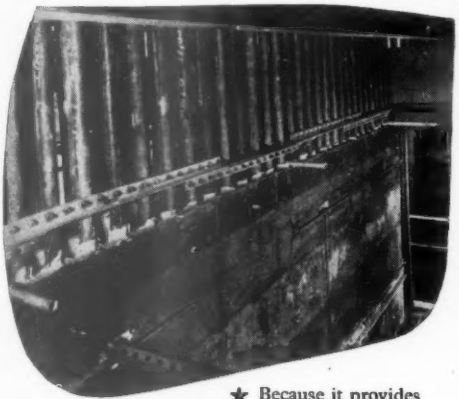
## REFRACTORY CONCRETE

*Above: Ipswich Power Station Bent Tube Baffle*

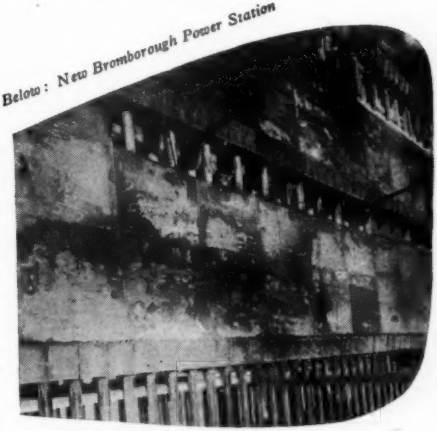


*Above: Deptford Power Station 6" by-pass baffle—superheater side*

*Below: Uskmouth Generating Station Economiser Baffle looking from rear right of boiler*



*Below: New Bromborough Power Station*



★ Because it provides a speedy, simple, economical method of monolithic construction.

★ It will stand up to years of wear and tear, vibration, mechanical and thermal shock.

★ It eliminates brick joints and reduces heat losses to a minimum.

★ It has low conductivity.

★ It is stable under load up to 1300°C. (2400°F.).

★ It has a high cold strength and is ready for full use 24 hours after placing.

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*You are invited to write for further details and photographic examples*

AP3-1037

# Current Prices of Iron, Steel, and Non-ferrous Metals

*(Delivered unless otherwise stated)*

**August 31, 1955**

## PIG-IRON

**Foundry Iron.**—No. 3 IRON, CLASS 2:—Middlesbrough, £17 1s. 0d.; Birmingham, £16 13s. 3d.

**Low-phosphorus Iron.**—Over 0.10 to 0.75 per cent. P, £18 12s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £19 8s. 3d.

**Scotch Iron.**—No. 3 foundry, £19 5s. 6d., d/d Grangemouth.

**Cylinder and Refined Irons.**—North Zone, £21 3s. 0d.; South Zone, £21 5s. 0d.

**Refined Malleable.**—P, 0.10 per cent. max.—North Zone, £22 0s. 0d.; South Zone, £22 3s. 0d.

**Hematite.**—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £19 5s.; Scotland (Scotch iron), £19 11s. 6d.; Sheffield, £20 12s. 0d.; Birmingham, £20 19s. 6d.; Wales (Welsh iron), £19 11s. 6d.

**Basic Pig-iron.**—£16 16s. 6d. all districts.

## FERRO-ALLOYS

*(Per ton unless otherwise stated, delivered)*

**Ferro-silicon** (6-ton lots and over).—45 per cent. Si, £40 15s. 0d., scale 15s. per unit; 75 per cent. Si, £63 0s. 0d., scale 16s. per unit.

**Ferro-vanadium.**—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

**Ferro-molybdenum.**—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

**Ferro-titanium.**—20/25 per cent., carbon-free, £230 0s. 0d.; 38/40 per cent., £279 0s. 0d.

**Ferro-tungsten.**—80/85 per cent., 17s. 6d. per lb. of W.

**Tungsten Metal Powder.**—98/99 per cent., 20s. 6d. per lb. of W.

**Ferro-chrome** (6-10 ton lots).—4/6 per cent. C, £83 0s. 0d. to £86 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £81 0s. 0d. to £84 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 11½d. per lb. Cr; 1 per cent. C,* 2s. 0d. per lb. Cr; 0.15 per cent. C,* 1s. 11d. to 2s. 1d. per lb. Cr; 0.10 per cent. C,* 1s. 11d. to 2s. 2d. per lb. Cr; 0.06 per cent. C,* 2s. 3d. per lb. Cr.

**Metallic Chromium.**—98/99 per cent., 7s. 0d. to 7s. 6d. per lb.

**Metallic Manganese.**—93/95 per cent., carbon-free, £249 0s. 0d.; 96/98 per cent., £269 0s. 0d.

**Ferro-columbium.**—60/75 per cent., Nb + Ta, 37s. per lb., Nb + Ta.

**Ferro-manganese** (home).—78 per cent., £53 17s. 6d.

## SEMI-FINISHED STEEL

**Re-rolling Billets, Blooms, and Slabs.**—BASIC: Soft, u.t., £26 19s. 0d.; tested, 0.08 to 0.25 per cent. C, £27 19s. 0d.; hard (0.41 to 0.60 per cent. C), £29 5s. 6d.; silico-manganese, £36 7s. 6d.; free-cutting, £31 0s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £34 12s. 0d.; silico-manganese, £36 7s. 6d.

**Billets, Blooms, and Slabs for Forging and Stamping.**—Basic, soft, up to 0.25 per cent. C, £31 11s. 0d.; basic, hard, over 0.41 up to 0.60 per cent., C, £32 13s. 6d.; acid, up to 0.25 per cent. C, £35 12s. 6d.

## FINISHED STEEL

**Heavy Plates and Sections.**—Ship plates (N.-E. Coast), £33 1s. 6d.; boiler plates (N.-E. Coast), £35 11s. 6d.; floor plates (N.-E. Coast), £34 10s. 6d.; sectional material, N.-E. Coast, £30 19s. 6d.

**Small Bars, Sheets, etc.**—Rounds and squares, under 3 in., untested, £33 19s. 6d.; flats, 5 in. wide and under, £33 19s. 6d.; hoop and strip, £35 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £36 5s. 0d.; black sheets (hand mill), 17/20 g., £46 13s. 6d.; galvanized corrugated sheets, 24 g., £54 14s. 0d.

**Alloy Steel Bars.**—1 in. dia. and up: Nickel, £58 0s. 3d.; nickel-chrome, £81 10s. 0d.; nickel-chrome-molybdenum, £92 7s. 6d.

## NON-FERROUS METALS

**Copper.**—Cash, £393 0s. 0d. to £393 10s. 0d.; three months, £385 10s. 0d. to £387 0s. 0d.; settlement, £393 10s. 0d.

**Copper Tubes, etc.**—Solid-drawn tubes, 3s. 6⅞d. per lb.; rods, 418s. 3d. per cwt. basis; 20 s.w.g., 451s. 6d. per cwt.

**Tin.**—Cash, £745 10s. 0d. to £746 0s. 0d.; three months, £745 10s. 0d. to £746 0s. 0d.; settlement, £746 0s. 0d.

**Lead (Refined Pig).**—Second half August, £107 0s. 0d. to £107 5s. 0d.; second half November, £106 15s. 0d. to £107 0s. 0d.

**Zinc.**—Second half August, £90 0s. 0d. to £90 5s. 0d.; second half November, £89 15s. 0d. to £90 0s. 0d.

**Zinc Sheets, etc.**—Sheets, 15 g. and thicker, all English destinations, £121 10s. 0d.; rolled zinc (boiler plates), all English destinations, £119 15s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

**Brass Tubes, etc.**—Solid-drawn tubes, 2s. 9¾d. per lb.; rods, drawn, 3s. 7¼d.; sheets to 10 w.g., 346s. 3d. per cwt.; wire, 3s. 4⅞d.; rolled metal, 346s. 3d. per cwt.

**Brass (Brazing).**—BS1400, B3 (65/35), £233; B6 (85/15), £310; BS249, —

**Brass (High Tensile).**—BS1400, HTB1 (30 tons), £300; HTB2 (38 tons), £293; HTB3 (48 tons), £325.

**Gunmetal.**—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £324; LG3 (86/7/5/2), £336; G1 (88/10/2/¼), £408; (88/10/2/1), £399.

**Phosphor Bronze.**—BS1400, PB1 (AID released), £421 per ton.

**Phosphor Bronze Strip, etc.**—Strip, 507s. 0d. per cwt.; sheets to 10 w.g., 530s. 6d. per cwt.; wire, 5s. 1¼d. per lb.; rods, 4s. 5¾d.; tubes, 4s. 4d.; chill cast bars: solids 4s. 6d. cored 4s. 7d. (CHARLES CLIFFORD, LIMITED.)

**Nickel Silver, etc.**—Rolled metal, 3 in. to 9 in. wide × 0.056, 4s. 5¼d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 10d.; special quality turning rod, 10 per cent.; ½ in. dia., in straight lengths, 4s. 9d. All prices are net.

**Other Metals.**—Magnesium, ingots, 2s. 4d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £90 0s. 0d. to £95 0s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £171 0s. 0d.; aluminium bronze (BS1400), AB1, £369; AB2, £376. Solder, brazing, BS1845, 3s. 0½d. lb.; granulated, 3s. 4½d. lb.

* Average 68-70 per cent.

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Powell Duffryn House
Adelaide Street
Swansea
Tel. Swansea 4035

## *News in Brief*

(*Continued from page 256*)

sprayed. The operator using the equipment escaped unhurt.

BOROUGH POLYTECHNIC, Borough Road, London, S.E.1, announce that a course of six lectures on the "Writing of Technical Reports" will be given by Mr. G. Parr, M.I.E.E., on Thursdays at 6.30 p.m., beginning on October 20. The lectures will cover the drafting of technical and scientific reports and memoranda, and they have been arranged by the Governors of the Polytechnic at the request of the Regional Advisory Council for Higher Technological Education in London and the Home Counties. The course fee is 10s.

IN ADDITION to five-day, two- and six-week residential courses held at their College in Kent, the College of Production Technology are organizing a number of external evening courses on materials handling and work-study between now and the end of this year. The courses are of six sessions duration—one session per week. The cities to be visited are:—London, Glasgow, Sheffield, Manchester, and Leeds. Full details may be obtained from the Registrar, College of Production Technology, Charing, Ashford, Kent (tel.: Charing 560).

FIFTY MEN at the Daimler factory at Coventry have been declared redundant, according to a statement issued by the company on August 23. The statement said: "Owing to continued shortage of certain materials, we have found it necessary for a period of time to reduce the number of employees by 50 on certain of our assembly lines. Every endeavour is being made to obtain adequate supplies of these materials, and as they become available additional men will be employed in sufficient numbers to cope with the demand for our products."

THE DIRECTORS OF LAKE & ELLIOT, LIMITED, announce that they have entered into negotiations to purchase the majority of issued ordinary shares in the National Steel Foundry (1914), Limited, Leven, Fife. The two companies will continue to trade as separate entities. They are related in their origins, as the late Mr. W. B. Lake, founder of Lake & Elliot, Limited, was the first chairman and managing director of the National Steel Foundry (1914), Limited.

A NEW FOUNDRY, four times the size of the one which has served their needs in the past, has been opened by the Consolidated Pneumatic Tool Company, Limited, at premises in Quay Road, Fraserburgh. The decision to extend the company's foundry activities has been made as part of the over-all planned expansion of their compressor business. The introduction by the company last year of a new-type rotary compressor brought numerous orders from overseas buyers. Since the beginning of this year £100,000 worth of new machinery has been installed at the Fraserburgh works to meet the demand.

A NEW 34-in. two-high reversing slabbing and blooming mill, destined for Turkey, has recently been completed in a British works prior to shipment. The plant is designed for an output of 400,000 ingot tons per year. It was ordered by the Sumerbank General Directorate, of Ankara, for the Karabuk Iron and Steel Works, from the Brightside Foundry & Engineering Company, Limited. The mechanical section has been designed and manufactured by the Brightside group; the auxiliary electrical equipment is also being supplied from Great Britain. The consulting engineers acting on behalf of the Turkish directorate are the International Construction Company, Limited.

## *Personal*

MR. SAMUEL R. HOGG and MAJOR CECIL R. DIBBEN have been elected directors of the London Aluminium Company, Limited.

MR. WALTER GRAINGER and Mr. JOHN MAYER have been appointed joint managing directors of International Combustion (Holdings), Limited.

MR. ROWLAND OWEN, C.M.G., comptroller-general of the Exports Credits Guarantee Department, is to visit North America during September.

THE BOARD OF TRADE announce that Mr. F. SHEPARD JOHNSON, J.P., has been appointed a member of the Council of Industrial Design to take the place of Mr. A. E. HEWITT, C.B.E., M.C., J.P., who has resigned.

MR. A. W. BRACE has taken charge of surface finishing activities of the chemical division of Aluminium Laboratories, Limited, Banbury. Mr. Brace joined the Aluminium Development Association in 1948, after several years with Magnal Products, Limited, Bristol, and the Bristol Aeroplane Company, Limited, engine division.

MR. MAURICE P. HENZELL, M.I.E.E., has been appointed operation and maintenance engineer (generation) at the headquarters of the South of Scotland Electricity Board, in Glasgow. He has been station superintendent at Portobello generating station since 1948, and was for two years previously station superintendent at Bonnybridge and Falkirk generating station.

Mr. P. HOESLI has left Light Production, Limited, Slough, to take up (on September 1) a position as liaison officer with British Non-Ferrous Metals Research Association, London. He will continue as secretary of the Slough section of the London branch of the Institute of British Foundrymen, but in future will operate from his home address—18, Huntercombe Lane, Taplow, Bucks.

Mr. A. E. S. GOURLAY has been appointed technical sales representative in Scotland to the Sheepbridge Group of companies. He will operate from 46, Hazelwood Avenue, Newton Mearns, Renfrewshire, the telephone number of which is Newton Mearns 3267. For the past 16 years, Mr. Gourlay has been a director and general manager of Clews Petersen, Limited, one of the southern companies of the Sheepbridge Engineering Group.

## *Obituary*

MR. HENRY WALKER, formerly a foreman for more than 20 years in the carriage and wagon department (British Railways), Derby, died on August 27 at the age of 72.

Mr. CHARLES D. RIGG, director and commercial manager of Smith & McLean, Limited, sheet and bar makers and galvanizers, Glasgow, died recently at the age of 71.

THE DEATH has occurred of Mr. WILLIAM TOWN, a founder-member of the firm of Frederick Town & Sons, Limited, Halifax, at the age of 73. He was a former president of the Halifax District Employers' Association.

Mr. ERNEST JOSEPH YARDLEY, one-time managing director of Wye Foundry, Limited, and a member of the Willenhall Urban District Council, died suddenly on August 18, at his home in Newton Ferrers, Devon, at the age of 74. He was also a past-chairman of the Willenhall Nursing Association.

# New Patents

*(Copies of complete specifications are obtainable from the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, London, W.C.2, price 3/-.)*

**735,155.** Dow Chemical Company, Midland, Michigan, USA.

This Patent applies to an apparatus for delivering metered shots of molten metal for castings, to a casting device such as a diecaster. The apparatus comprises a vessel for holding molten metal; a pipe which has one end extending into the vessel at a point near the bottom. The other end of the pipe is outside the vessel between the bottom of the vessel and the operating level of the molten metal in the vessel. A valve on the end of the pipe within the vessel controls the metering of the metal shots. The invention has among its advantages the elimination of oxidation or burning of molten metal, and the prevention of dripping or dribbling of molten metal.

**735,197.** R. J. Richardson, Glenthorne, Lanpark Road, Pontypridd, Glamorgan.

This Patent has been specially related to the dust laden air of fettling shops in many foundries. It is for an improved face-mask which consists of a nose-piece surrounding the nose, the lower part of this piece extending downwards as a hood in front of and clear of the upper lip; and a tube passing into the nose piece to serve for the introduction of uncontaminated air. The clear passage allows for the escape of air as a curtain in front of and below the mouth of wearer. Provision can also be made for the mask to incorporate an eye shield—the air supplied to the mask escaping into the eyeshield to obviate the ingress of dust to the eyes and also to prevent condensation of moisture on the window.

**735,267.** Babcock & Wilcox Company, 161 East 42nd. Street, New York, 17, USA.

A metal-casting apparatus which consists of a metal-melting furnace, a ladle adapted to receive the metal, and a pouring station so arranged as to pour the metal from the ladle to a mould. A holding station is arranged between furnace and pouring station to receive and support the ladle. A molten-metal stirring device is situated at the holding station to stir the metal in the ladle whilst at that station.

**735,286.** G. W. Taylor, The Hermitage, Avenue Road, The Causeway, Staines, Middx.

An apparatus for the separation of a pattern from moulding sand. A steel plate is recessed into the pattern and screwed down. An electromagnet is then brought into engagement with the pattern. A means is provided for vibrating the magnet for a few seconds to cause a gap between pattern and sand. The pattern can be removed then with no damage either to it or to the mould.

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**Maintenance of Electric Motors**

"Keep Your Motors Running," a booklet published by Brook Motors, Limited, Huddersfield (1s.), contains 128 pages of useful information for the motor user. Motor construction details, a lengthy list of horse-powers required to drive a wide variety of machines, installation and maintenance information, and a fault finding section are some of the more important items. Connection diagrams, tabular information, and a section on control gear complete the book.

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# CLASSIFIED ADVERTISEMENTS

**PREPAID RATES:** Twenty words for 5s. (minimum charge) and 2d. per word thereafter. Box Numbers 2s. extra (including postage of replies).

**Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, John Adam House, 17/19, John Adam Street, Adelphi, London, W.C.2. If received by first post Tuesday advertisements can normally be accommodated in the following Thursday's issue.**

## SITUATIONS WANTED

HEAD FOREMAN. Skilled moulder, knowledge in all classes of foundry practice. Accustomed to full control. Experienced in floor, bench, plate, and machine moulding. Training of unskilled labour.—Box HF447, FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRY MANAGER/FOREMAN (46), M.I.B.F., life experience trade, practical/technical/rates/commercial/sales, wants position Midlands, prospects essential. Assistance Housing appreciated. Proved ability; references. Box EF459, FOUNDRY TRADE JOURNAL.

PATTERNMAKER (27), educated to O.N.C. mechanical. Experienced in jobbing and mechanised foundry work. Desires position with scope for advancement, preferably where evening study of metallurgy is available. Box PM462, FOUNDRY TRADE JOURNAL.

## SITUATIONS VACANT

*The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.*

BRASS Gravity Die Casting TECHNICIAN required for a growing Foundry specialising in the production of Plumbers' Brass-ware. Applicant must have a complete knowledge of this branch of the foundry trade and be capable of organising and maintaining a high rate of production. This is a position for a very energetic and determined personality. Age not exceeding 40. Salary in accordance with experience. Contributory pension scheme. Southern area.—Box BG326, FOUNDRY TRADE JOURNAL.

THOROUGHLY experienced METALLURGIST required to take complete charge of metal melting and analysis in iron foundry producing castings to varied specifications.
ROBERT CORT & SON LTD., Reading Bridge, Reading.

DRAUGHTSMEN. — Applications are invited from Senior and Junior Draughtsmen to fill positions which have resulted from our expanding commitments. The work would involve the design and detailing of welded fabrications, pipework and light steel structures in connection with major installations. Excellent prospects of subsequent promotion exist for persons having initiative and an ability to accept responsibility.—Candidates should apply in writing to W. C. HOLMES & Co., LTD., Huddersfield, giving full details of previous experience, etc.

SENIOR FOUNDRY FOREMAN required for progressive grey iron foundry, South Yorkshire Area. Sound experience chief requirement, and ability to control floor moulders. Prospects of advancement. Write stating age, experience and salary required to Box SF440, FOUNDRY TRADE JOURNAL.

## SITUATIONS VACANT—*contd.*

STEEL FOUNDRY SALES REPRESENTATIVE required by small steel foundry in Sheffield, capable of estimating weights from drawings, pricing the castings and subsequently visiting customers. The position would be partly inside and partly outside work, with a view to ultimately taking full responsibility as Sales Manager. Previous steel foundry experience is essential and applicants should be preferably between the age of 30 and 35 years. Replies giving details of experience, salary expected, etc., will be treated in the strictest confidence, to Box SF433, FOUNDRY TRADE JOURNAL.

### BRITISH STEEL CASTINGS RESEARCH ASSOCIATION.

APPLICATIONS are invited from GRADUATES with some research experience to work under the direction of Dr. T. P. Hoar in the Department of Metallurgy at Cambridge University, on problems relating to steel castings. For this work the British Steel Castings Research Association offers a Fellowship with emolument in the range £600—£650, according to qualifications.—Applications should be addressed to Dr. T. P. HOAR, The Department of Metallurgy, Pembroke Street, Cambridge.

NON-FERROUS Foundry in North London requires a WORKING CHARGEHAND. Specialised quality copper alloy castings main output. Good prospects for keen young man willing to work.—Apply, giving general particulars, to Box NF448, FOUNDRY TRADE JOURNAL.

DESIGNER (aged 25 to 40) required for work in new and expanding field of dust control. Successful applicant will eventually be responsible for complete design of dust control and ventilation systems and equipment. Applicants should be at least H.N.C. standard, and should have served an engineering apprenticeship. Previous experience of this kind of work desirable but not essential. Starting salary according to age and experience.—Reply in writing, stating age, qualifications, experience and present salary, to W. C. HOLMES & Co., LTD., Huddersfield.

DESIGNER (aged 25 to 40) required for work in new and expanding field of dust control. Successful applicant will eventually be responsible for complete design of welded fabrications associated with dust control. Applicants should be at least H.N.C. standard and should have served an engineering apprenticeship. Previous experience of this kind of work in connection with chemical and gas plant and some electrical knowledge desirable. Starting salary according to age and experience.—Reply in writing, stating age, qualifications, experience and present salary, to W. C. HOLMES & Co., LTD., Huddersfield.

FOUNDRY CHEMIST and METALLURGIST required for Malleable and Grey Iron Foundry. Excellent opportunity for young man. Salary in the neighbourhood of £500 depending on experience. Apply in writing to RESIDENT DIRECTOR, Shanks Ironfounders Ltd., Dens Iron Works, Arbroath.

## SITUATIONS VACANT—*contd.*

PATTERNMAKERS used to first class Wood and Metal work required by Coventry firm of Master Patternmakers. Top wages and excellent conditions. Box PU442, FOUNDRY TRADE JOURNAL.

FOREMAN PATTERNMAKER required for S.E. London Pattern Shop. Good disciplinarian.—Box FP449, FOUNDRY TRADE JOURNAL.

IRON MOULDERS and COREMAKER, also experienced FURNACEMEN and FETTLER required for Jobbing Foundry, Nottingham district. State experience and wages required. Box I.M.460, FOUNDRY TRADE JOURNAL.

FOREMAN required for Iron Foundry in South Coast area producing Machine Tool and General Engineering castings. Energetic man with sound knowledge of Foundry practice and ability to supervise and train labour. Box FR467, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY MANAGER required for new Shell Moulding Foundry in the Birmingham district. Applicants should state experience, age and salary required to Box AF468, FOUNDRY TRADE JOURNAL.

METALLURGISTS required for research and development work on Magnesium base alloys. Preference given to men with good honours degree, but other applications will be considered. Permanent appointment with contributory pension and life assurance. Apply stating reference FJ424, age and details of qualifications and experience to SECRETARY, Magnesium Elektron Limited, P.O. Box No. 6, Lumm's Lane, Clifton Junction, Swinton, near Manchester.

PATTERN MAKER required, experienced in wood and metal. Apply WELLWORTHY, LTD., Ampress Works, Lymington, Hants.

ASSISTANT FOREMAN required, with a view to up-grading to FOREMAN in charge of modern Non-Ferrous Foundry in Nottingham area. Excellent prospects of advancement in expanding concern. Applicants should state age and give details of previous experience. Apply Box AF475, FOUNDRY TRADE JOURNAL.

### FOUNDRY METHODS ENGINEER.

AN excellent opportunity occurs for young man of ability in large modern foundry, casting up to 200 tons weekly; medium and light castings for own products.
Candidates should have served full apprenticeship in modern foundry and be familiar with pattern layout for machine and shell moulding. Preference will be given to graduates of the National Foundry College.
The post is intended to be permanent with commensurate salary and generous pension scheme. Box FM471, FOUNDRY TRADE JOURNAL.